ENGINEERING NEWS-RECORD

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In the News:

EIGHT CHAPTERS of the construction code have been approved to date. Roofing and sheet-metal and plumbing codes are scheduled for early approval.

REAL-PROPERTY-INVENTORY results to date (for ten cities) show that 36 per cent of residential structures need minor repairs and 20 per cent major repairs, according to Dr. Willard Thorp of the Commerce Department.

A CODE MANUAL for the construction industry is announced by the Construction League for early appearance.

AN EMERGENCY PROCLAMATION on water conservation has been issued by Governor Henry H. Blood of Utah. Drought conditions are growing steadily worse, so that concerted action is necessary to prevent all misuse or waste of water throughout the State.

MUNICIPAL bond-market improvement is reflected in figures just released by PWA relative to its loan-and-grant business. To date, 193 cities have asked to have their loans and grants changed to grants only, preferring to borrow in the open market. Nearly $25,000,000 of earmarked PWA funds has been released in the process.

MEETINGS of the Construction League and of the A.G.C. in Washington last week were almost wholly occupied with code matters. Both the League and the General Contractors are busily extending their organizations to cope with code administration problems.

MICHIGAN'S 5-to-1 vote against a bond issue of $38,000,000 for public works is attributed to those who have fostered charity and fought taxes. Nearly one-quarter of the state's population is unemployed in spite of the fact that employment in the automobile industry has been maintained at a high figure.

In This Issue:

NOTABLE FOUNDATION WORK characterizes the construction of the new bridge over the Mississippi River at New Orleans. By the use of artificial sand islands the difficult task of sinking 65x100-ft. piers 170 ft. below low water in unstable silt has been successfully accomplished. Steel superstructure erection is now beginning.

LOW-HEAT CEMENT will be used for the Tennessee Valley dams. Specifications for this cement, a quantity of which has already been purchased, are closely similar to those used for the most recent Boulder Dam requirements.

NEW EMPHASIS on erosion control is one of the important results of current government activity. An article is this issue presents useful hydraulic data relative to the capacities of culverts used in check dams.

SEWAGE-PLANT DATA from Aurora, Ill., comprise the fourth article in the plant-survey series.

A WATER-SOFTENING PLANT involving several unusual features has recently been completed in Evansville, Wis. The raw-water basin is placed in the basement beneath the settling basin. The mixing chamber is a timber reaction tube containing agitator paddles. The plant is unusually compact.

TUNNEL VENTILATION during driving is a major factor affecting tunneling costs. The plant itself is expensive, and its functioning largely determines workmen's efficiencies. Using Colorado River Aqueduct practice as an example, design procedure is outlined, and graphs and tables give data for equipment selection.

CONSTRUCTION for the first time found a place on the annual meeting program of the U. S. Chamber of Commerce. Sessions devoted to the problems of the capital-goods industries and to PWA and related questions produced data and views of moment to the engineer and the contractor.

PERMEABLE DIKES in combination with bank revetment are the principal tools being used to effect channel regulation on the Mississippi River between Cairo and St. Louis. The work, which is nearing completion, is described by Capt. Harloe, district engineer, St. Louis.

A NEW RECORD for high-wind measurement was set by the Mt. Washington weather station when its anemometer chalked up a 231-mile-per-hour velocity. Interesting facts relative to the apparatus, the record wind and high winds in general are contributed by Prof. Charles F. Brooks of Harvard.

Coming Articles:

REVETMENTS to protect the river banks from attack by flood currents are one of the major items of expense in the operations of the Mississippi River Commission. An article soon to be published will describe two new types of revetments recently developed, in an effort to get better protection at reduced cost as compared with types in use heretofore. In the New Orleans district, asphalt is being fabricated into thin mats reinforced with wire mesh and laid on caving banks in large sheets; in the Vicksburg and Memphis districts tetrahedral blocks of concrete are being made for use in place of stone riprap on banks subject to attack by the river.

Rejuvenation of One Old-Timer

Krempel & Erkes, Los Angeles, were the architects who made a modern building out of this old-timer (*right*)

William Trewhella was the Los Angeles plastering contractor who helped to rejuvenate this old-timer

Problem: To convert a dwindling tenant list to an expanding one; to change dropping rentals to rising ones.

Reason: One dingy, out-dated hotel and store building. (See above).

Answer: Off with over-hanging bays, pie-crust ornaments. On with smooth, clean, sturdy Velvatone stucco (made with Atlas White portland cement), troweled to simple, modern lines.

Result: A tenant-catching, rental-boosting structure, brand-new in appearance, fresh, modern, inviting. (See below).

Suggestion: For prompt, complete information on Atlas White, not only for stucco but also for fine terrazzo, for cast stone, for non-staining mortar, for other uses, write Universal Atlas Cement Co., *Subsidiary of United States Steel Corporation*, 208 So. La Salle St., Chicago.

ATLAS WHITE PORTLAND CEMENT

ENGINEERING NEWS-RECORD

New York

May 10, 1934

Pier Sinking Through Sand Islands at New Orleans

Four piers in the Mississippi River will have footings 170 ft. below low-water level—Pier caissons built on artificial sand islands are being sunk by dredging in open wells without use of compressed air

SINKING the pier foundations of the Mississippi River Bridge at New Orleans to a stable bearing at depths down to 170 ft. below low water through artificial sand islands is proving to be an eminently successful method of attacking a difficult job. At the time this is written caissons for two piers in the river channel (Piers 2 and 3, Fig. 2) have been sunk to El. —170, and the caissons have been sealed; the sand island for a third (Pier 1) has been completed, and sinking of the concrete caisson has started; and at the fourth pier work on the sand island is under way, the protective mat on the river bottom having been sunk some months ago as part of the general operations of sinking mats to protect the bottom from scour at each of the main river piers.

The bridge is to cross the Mississippi River about 6 miles west of the central business district of New Orleans (the river running in a general west-to-east direction past the city) and about 3 miles beyond the city limits on the Jefferson Highway. It is being built jointly by the state of Louisiana and the Public Belt Railroad Commission at a cost estimated at $13,000,000. Financing was made possible by an RFC loan. Upon completion, the bridge will be used jointly by the Public Belt R.R. and the railroads entering New Orleans from the West and by the state highway department.

Because of the low level of land on both sides of the river and the high clearance over the river required by the War Department (135 ft. above high water over a 500-ft. channel width), the bridge and approaches have a total length of 23,000 ft. The main river crossing has a total length of 3,525 ft. and is made up of a main 790-ft. cantilever span with 530-ft. anchor arms, one 531-ft. through-truss and four deck trusses of 333 to 269 ft., as shown in Fig. 2. Grades on the four main through-spans of the bridge for both railway tracks and highway decks will be 1.25 per cent up to a vertical curve on the cantilever span, but on four deck trusses of the river crossing and on the approach viaducts the two 18-ft. highway decks, carried as cantilevers on each side of the trusses and viaduct towers, have their grades increased to 4 per cent. The railroad grade is 1.25 throughout. The railway deck is to be of creosoted timber, entirely covered with galvanized sheets of copper-bearing steel as a precaution against fire from sparks.

Most of the concrete highway deck of the north approach has been placed, and laying of the railway deck was about

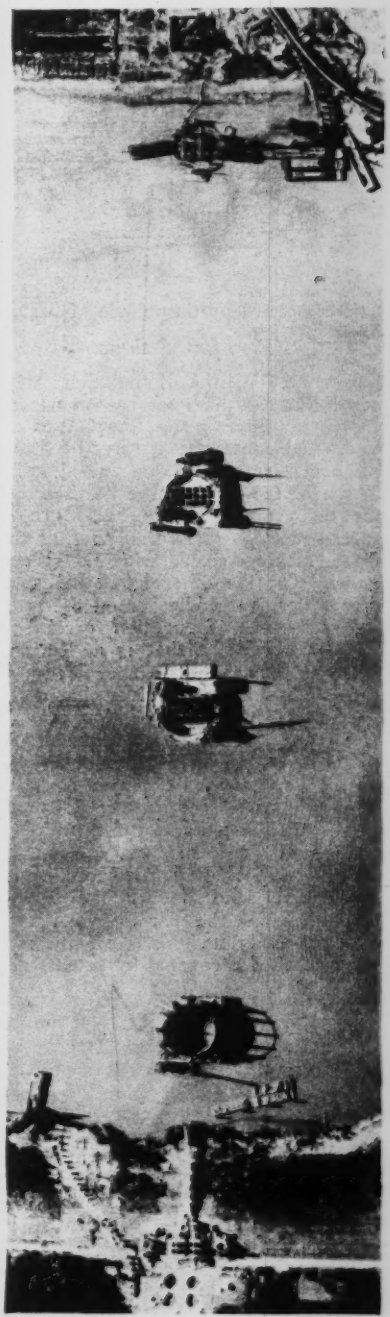


FIG. 1—ARTIFICIAL SAND ISLANDS are used to facilitate construction of the piers of the New Orleans Bridge. The islands for four piers, Nos. 1, 2, 3 and 5, reading from the bottom, are shown in this airplane picture. Construction of the island for Pier 4 has been begun since this picture was taken. At the lower edge of the picture is excavation for a viaduct tower footing, and above it, adjoining the road, is Pier A.

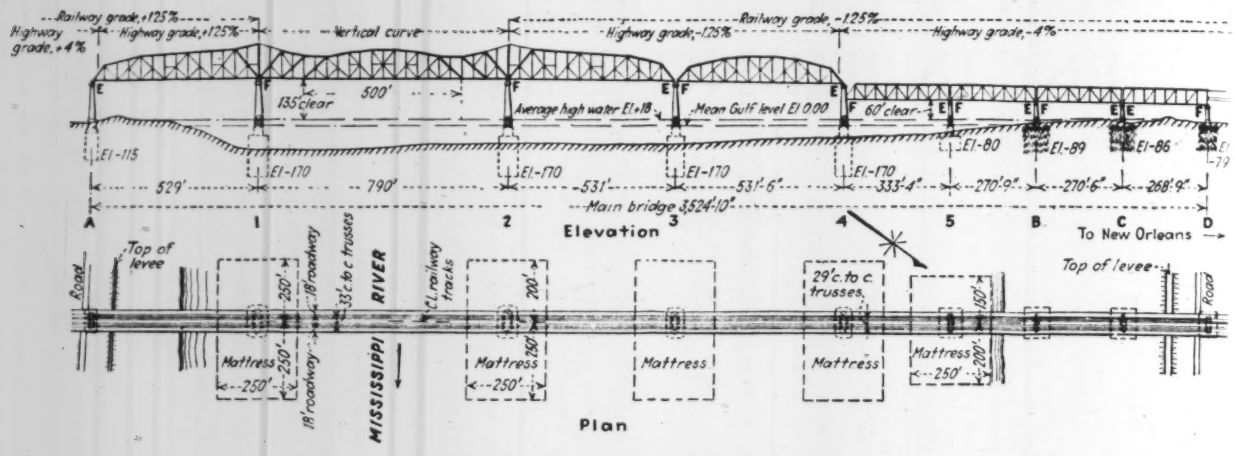


FIG. 2—MAIN RIVER CROSSING of the combined railway and highway bridge across the Mississippi River above New Orleans.

half completed by the middle of March.

Pier foundations

Interest in the foundation work centers in the piers for the main river crossing. The viaduct foundations are of normal construction, spread footings of concrete carried on wood piles. Three of the piers at the north end of the main river crossing also are on spread footings carried on piles, as that is a "making" bank with no risk of scour. On the other hand, the south pier (Pier A), while behind the levee, has a caisson foundation carried to El. —115 because that is a "cutting" bank with possible danger of scour through a shift in the river channel.

The following description of the pier-caisson sinking operations applies to Piers 1, 2, 3 and 4, as numbered in Fig. 2. The method employed is similar to that used by the present contractor in sinking the piers of the Suisun Bay Bridge in California (*ENR*, Jan. 30, 1930, p. 174). It consists of forming an artificial sand island at the pier site through which the pier caisson is sunk by open-dredging. Certain features of the method are covered by patents held by Nick F. Helmers and M. F. Clements, St. Paul.

No sand island was required in sinking the caisson for Pier A as it is on dry land; the caisson for Pier 5 was sunk through an artificial sand island, as in the case at Piers 1 to 4; but since it is in shallow water, the island was formed within a ring of vertical steel sheetpiling instead of in a special steel shell as in the other four piers; otherwise the procedure was identical with that to be described.

The river bottom is composed of layers of silt, sand, clay, or mixtures of all three to unknown depths. Near the surface the material is highly unstable and easily eroded. Because of this latter condition, willow mattresses 250 ft. wide and of varying lengths up to 500 ft. parallel to the direction of river flow were woven and sunk with riprap at the site of each of the five piers in the river (*ENR*, Aug. 17, 1933, p. 190), and within the area so protected against scour each pier is being built.

Upon completion of the mattress, a ring of falsework consisting of pile bents is constructed around the pier site, the inclosed circle having a diameter of 121 ft. at Piers 1 and 2, and of 111 ft. at Piers 3 and 4. Piles of Oregon fir ranging in lengths up to 135 ft. and driven to a penetration of about 25 ft. are used for this falsework.

Erection of the circular steel shell for the sand island is then begun within the falsework, each ring of the shell being made up of twelve curved sections. The lower steel ring is 5 ft. high, the next two are 2½ ft. high, and the remainder are 10 ft. high. Shell thicknesses range from ½ in. up, depending upon the vertical position of the ring in the finished shell.

The 2½-ft. high rings are employed near the lower edge to permit salvaging the largest possible amount of the shell upon completion of the operation.

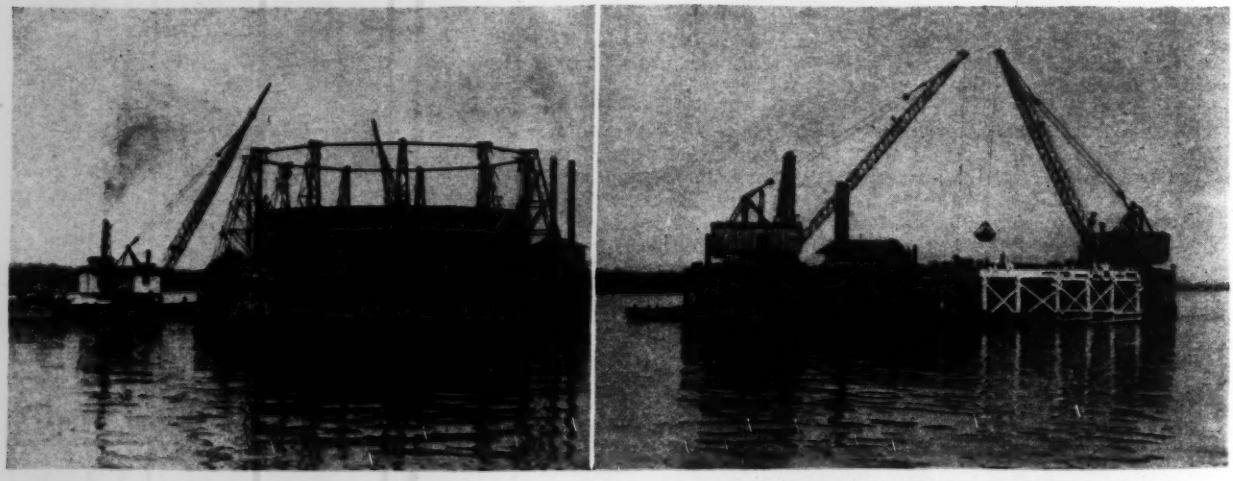


FIG. 3—TWO STAGES in the sand-island construction are here shown. At the left are the derrick frames for lowering and raising the sand-island shell in place on the falsework. In this stage floating derricks are employed. At the right, after the shell has been sunk, two large revolving derricks are set up on the falsework to place the sand fill, dredge out the caisson and remove the sand fill after the caisson has been sunk and sealed.

The steel shell, to a height of 30 ft., is assembled on short needle beams along the inner face of the falsework, using either a floating derrick or derricks set upon the falsework. Upon completion of the 30-ft. section, twelve hoist frames are set up around the inner edge of the falsework, as shown in Fig. 3; and after the weight of the shell has been transferred to the hoists, the supports are withdrawn and the shell lowered 30 ft. When in lowered position, the shell weight again is transferred to needle beams at the deck level, and another 30 ft. section is erected. This process is continued until the steel shell is seated on the mattress on the bottom and extends to a safe distance above water level. The hoist towers then are taken down to clear the deck of the falsework for subsequent operations. At Piers 1 and 2 the shell so built was 100 ft. high, and at 3 and 4 it was 70 ft. high.

Although the operating scheme is varied somewhat to suit special conditions at each pier, the general plan calls for largely self-contained operations at each pier. For this purpose two large revolving derricks are mounted on opposite sides of the falsework ring on extensions of the falsework that roughly correspond to the corners of the square inclosing the ring. At a third corner there is a boiler plant supplying steam for operations requiring it. For use at the two larger piers, Nos. 1 and 2, the revolving derricks were specially built in order to meet the conditions created by the great size and depth of the excavation. They have 100-ft. booms and a lifting capacity of 12 tons at 85-ft. radius. They are equipped with check lines to keep the dredge buckets from spinning in the long lift from the bottom of the excavation.

The airplane view of the river crossing (Fig. 1) shows the steel shell being assembled for Pier 1 (first river pier in the foreground), concrete caissons under construction at Piers 2 and 3, and Pier 5 under construction in shallow water near the far shore. On the shore is the rectangular excavation for Pier B, a pier carried on piles. Work on Pier 4 had not started when this picture was taken. The general shape of the timber falsework at the other piers is clearly shown.

Following the sinking of the steel shell, the mattress within the shell is cut and pulled out, a pile hammer being employed to actuate the heavy chisel used to cut around the inner edge of the shell. With the mat out, filling the shell with sand is begun and is continued until the surface is above water level. The amount of settlement of the ring during the filling operation is surprisingly small, being only about 5 ft. at the deeper piers.

Sand for the filling is dredged a short distance up the river near the Southern Pacific Railway ferry slip at a point where the railway company finds it necessary to dredge currently to maintain a channel. It is brought down to the bridge in barges, and the two derricks on the pier falsework, operating 3-yd. buckets, place it within the shell.

On the island thus formed caisson sinking is carried forward by dredging through wells in the caisson, the caisson walls being built up as it sinks. Details of a typical caisson are shown in Figs. 4 and 5. Except for the temporary top, which is of timber, it is a cellular structure of reinforced concrete, with walls generally vertical except for keyways to increase the hold of the tremie concrete in the seal, an offset near the bottom of the outside wall to reduce skin friction, and an outward batter near the top of the cross-walls to increase the bearing of the distributing block under the pier proper.

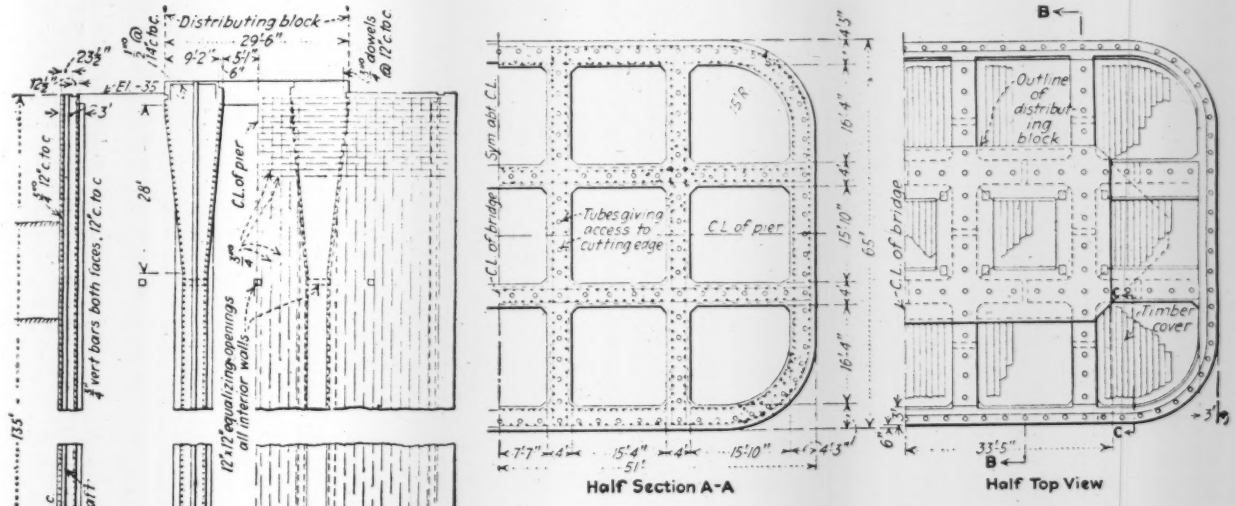


FIG. 4—CAISSONS for the larger piers are 65x102 ft. in plan. The pier is built on a distributing block, indicated in outline, that rests on top of the cross-walls. The dredge wells are left open above the level of the tremie-concrete seal to reduce the weight on the foundation. Details of the piers are shown in Fig. 7.

Sliding steel forms are used in the construction of the concrete caissons, a special wedge-shaped section being included to provide for the batter of the upper part of the cross-walls. Each set of forms will have been used 28 times when the job is complete. The caissons are built up in 10-ft. lifts.

From the sections through the caisson shown in Fig. 4 it will be noted that 8-in.-diameter wells are formed into the concrete in both the outer walls and in the cross-walls to facilitate cutting obstructions from under the walls. In the sinking operations carried on to date these wells have not been needed. Set in the outer walls are 8-in.-diameter jet pipes leading to outlets near the cutting edge. These were included in the design as a precaution against skin friction overcoming the weight of the caisson, the contractor being required to equip a high-pressure pumping plant to supply water to them if needed. To date, this precautionary measure has not yet been brought into play, but the contractor has made good use of the high-pressure pumping plant in the sand-dredging operations.

Dredging within the well is begun as soon as the caisson has reached a height of 20 ft. (two lifts of the sliding forms) and is carried forward until the predetermined depth is reached. In this work care is exercised in maintaining the water level within the caisson as close as possible to that of the river, thus minimizing the risk involved in building up hydrostatic pressure that might cause blows through the unstable river-bottom material.

So far, no unusual difficulties have delayed the work. Such hard layers as have been encountered have been cut through successfully by the expedient of dredging deeply close to the cutting edge of the caisson, undermining the hard layers that were encountered until they broke of their own weight and caved into the excavated pit.

The upper part of each caisson, the cofferdam for the pier, is of timber, 12x12 and 7x12, drift-bolted and calked. This timber section is employed on each caisson above El. —35, so that there will be no permanent caisson above that level to obstruct the river channel. The timber section is securely anchored to the concrete by hook rods extending down from the top and so arranged that they can be unhooked from the top to release the timber section after the pier has been carried up above water level.

For the four main river piers the concrete section of the caisson is 135 ft. high and the timber section is 50 ft., a total of 185 ft., or a margin of 15 ft. above low water as a protection against flooding.

After the cutting edge has reached the predetermined depth (the top of a thick layer of sand disclosed by test boring to have ample bearing capacity), dredging is carried down to a depth of 6 to 8 ft. below the cross-walls. The bottom then is leveled as well as is possible with the dredge buckets, and if the dredged material checks with that determined by the test borings, the tremie concrete seal is placed.

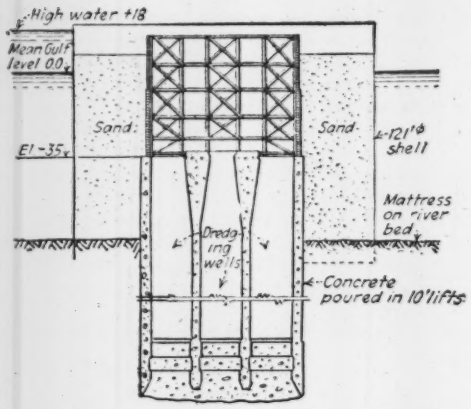
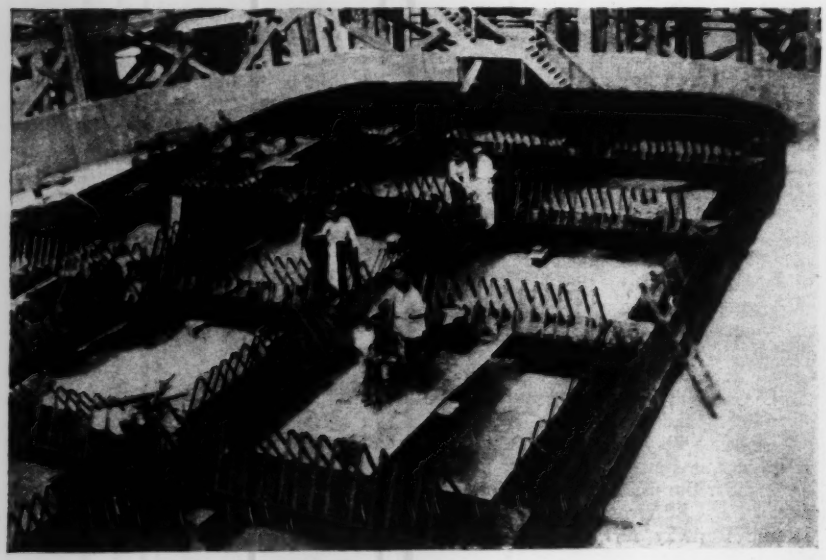


FIG. 5—THE RELATION of a pier caisson to the sand island is shown in this section on the short axis of a typical pier.

Before placing the seal the lower ends of the dredge wells are cleaned by lowering into each well a jet pipe with jets at the ends of two horizontal crossarms.

In placing the tremie seal of Pier 2 it was not found possible to place the entire seal in one operation. Attempts to dredge the entire bottom area to a depth of 5 to 6 ft. below the cutting edge resulted in further sinking of the caisson. Consequently, the nine center wells were dredged to the specified depth, leaving the end wells incompletely dredged, and the seal was placed in the central group. Twenty-four hours later the six end wells were dredged out and sealed. The seal generally is about 25 ft. thick.

FIG. 6—THE CUTTING EDGE of each caisson is assembled in the position in which it is to be sunk. Part of the circular shell forming the sand island is shown across the top of the picture.



Placing of tremie concrete in seals of Piers 2 and 3 is believed to be the largest tremie concrete operation at comparable depths attempted. The maximum water depth was 173 ft., and the tremie pipe had a total length of 191 ft. At the Morgan City Bridge over the Atchafalaya River (*ENR*, Dec. 28, 1933, p. 776) tremie concrete for a smaller pier was placed at a depth of 176.5 ft. below water level.

Four 10-in. tremie pipes with 2-cu.yd. hopper were used in each operation, the ends of the pipes being kept submerged in the concrete at all times. Concrete was delivered to the pipes in rotation in order to keep the flow uniform. No plug was lost in any of the tremie operations carried out to date. The seal of Piers 1 and 2 required 3,400 cu.yd. of concrete, and that of the smaller piers 2,300 cu.yd.

In dredging the end wells of Pier 3 some of the concrete from the seal of the center wells was broken off and brought to the surface. It was found to be in perfect condition, free from segregation or washing.

Caisson unwatering

Unwatering of the cofferdam down to the top of the concrete is not begun until about ten days after the seal has been completed. In unwatering Pier 3 (the first of the deeper piers to be unwatered) a negligible amount of leakage into the caisson developed, although the unbalanced head exceeded 40 ft.

In the finished pier the dredge wells are not filled with concrete above the top of the seal but are left open and flooded in order to reduce the total weight of the pier. The pier proper is carried on a distributing block, a slab of reinforced concrete set over the central dredge wells, as indicated in Fig. 7. As a preliminary to the construction of that block, the dredge wells are decked over below the level of the tops of the cross-walls. Unwatering of the caisson, therefore, is carried only to a depth sufficient to permit the decking to be placed. The tops of the concrete cross-walls then are washed off, the reinforcing rods are straightened up and forms set for the distributing block.

In constructing the distributing block the main members of the crossbracing of the timber section of the cofferdam are left in place and are buried in the concrete. Subsequently they are cut off flush with the surface and the load transferred to the face of the concrete with wedges. In the pier proper, which is faced with granite, similar practice is followed except that the timber is cut off back of the granite face stones.

When the pier work is above water level, the caisson is flooded so that the timber section can be disconnected from the concrete base, floated to the surface and removed. Piers 1 and 2, flanking the main navigation channel, are to have

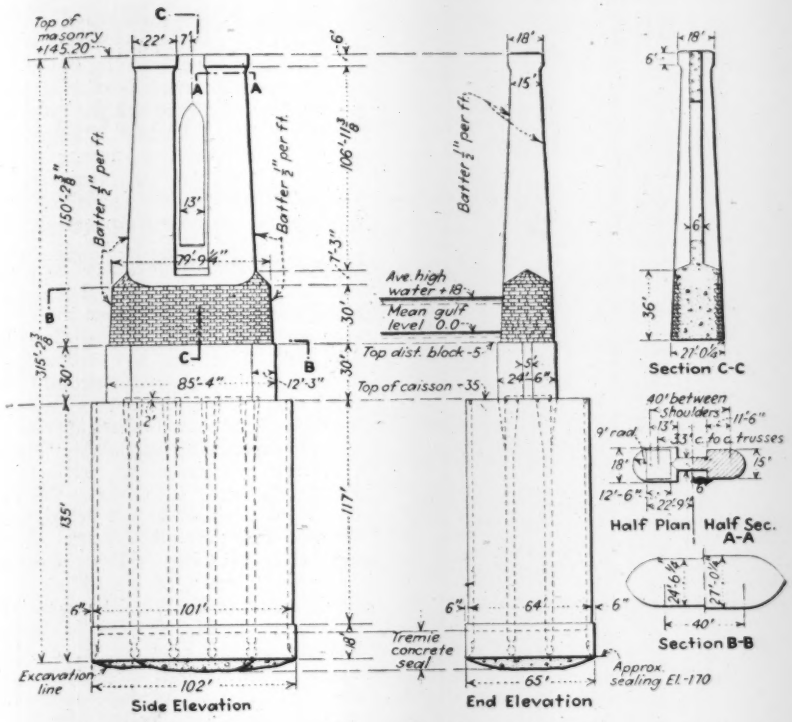


FIG. 7—THE PIERS have a maximum height above the bottom of the caisson of 315 ft. Above a level 35 ft. below low water they are made narrow in order to introduce as little obstruction to the channel as possible.

fenders of creosoted timber. These fenders will be supported on the distributing block and secured to the piers by steel rods extending back into the concrete core through the joints in the granite facing.

Sand-island removal

Removal of the sand islands is begun as soon as the cofferdam has been sealed. Sand inside the island is first dredged out, using the derricks on the pier falsework; when the bottom has been reached, a diver goes down on the inside and unbolts the lowest ring of the steel shell that he can reach. To facilitate this operation, special lug bolts are used, and the bolt holes are slotted so that a diver can knock the bolts out as soon as they are loosened. To date, only a small amount of the shell has been lost through being buried in the river bottom.

The steel shells for the sand islands are removed by reversal of the sinking operation, the twelve hoist frames being reset on the falsework and used to raise the shell from the bottom. Actual dismantling usually is done with floating derricks, as a derrick on the falsework cannot work to advantage with the hoist frames in place. Also, the sequence of operations requires the transfer of the large derricks to a new pier as soon as the sand shell has been dredged out.

After the shell has been removed, the inclosed area on the river bottom from which the protective mat was cut away at the start of the operation is covered with riprap to minimize the possibility of scour close to the piers.

Construction plant

Except for the revolving derricks and boiler plants mounted on the pier falsework, most of the pier contractor's plant is floating. The largest unit is the concrete plant. It includes oil-fired steam boilers supplying power for lighting, air compressors, cement pump, concrete mixers and hoist, and for the winches operating the maneuvering lines. There also is a revolving derrick on the concrete plant barge to transfer sand and gravel from the supply barges to the hoppers over the mixing plant. All materials are delivered by barge, the contractor having three bulk-cement barges of 1,500-bbl. capacity operating on the river between the job and the cement mill. Cement is pumped from the barges to the mixing plant.

The mixing plant contains two 2-cu.yd. mixers, served by automatic weighing batchers, discharging to a common hopper at the base of a 120-ft. distributing tower mounted on the forward end of the barge. The plant has a capacity of 100 cu.yd. per hour.

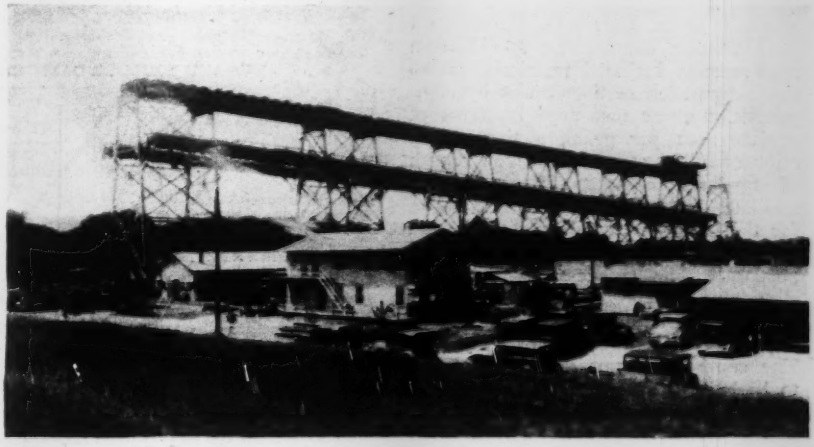
Concrete for all work on the river piers is delivered direct from the tower chute. For the piers on land the concrete was delivered by the floating plant to buckets on rail cars run out to the end of the construction trestles at the water's edge.

The sand dredge is another important element in the floating plant, its character being dictated in large part by the fact that a high-pressure pumping plant had to be supplied for possible use in the caisson sinking. Modification of the pumping plant for use in dredging is simple, an ejector-type dredging element being used to raise a mixture of sand and water to a flume supported on brackets against the long side of the house over the pumping plant, from which it is discharged through short chutes to a barge lying alongside the pump barge.

Approach viaduct construction

Construction of the long approach viaducts of steel girder and bent type on each side of the river is being carried forward independent of the work on the main-channel spans, under separate contracts for both foundations and super-

FIG. 8—VIADUCT APPROACHES consist of steel-tower-bent-and-girder construction. Tower spans are 45 ft., and intermediate spans from 69 to 82 ft. The railroad is carried on top, while the highways are cantilevered from the sides but come to grade in a much shorter distance than does the railway. The buildings are the contractor's and engineer's headquarters.



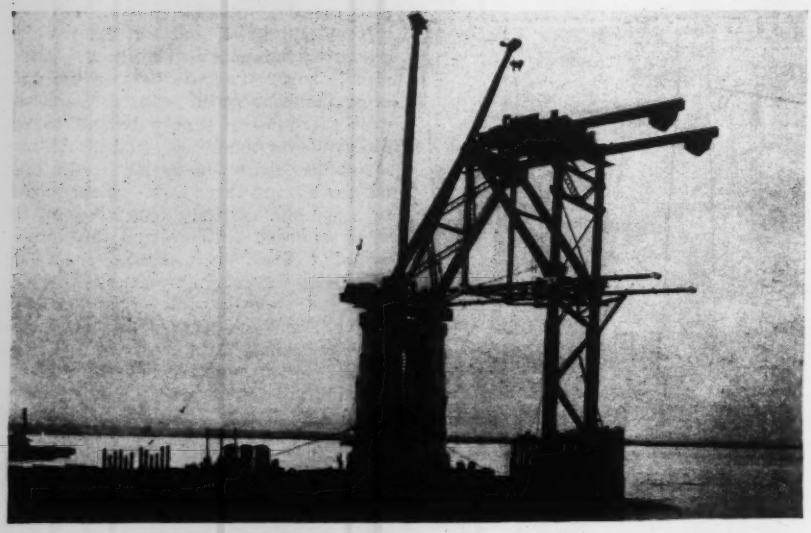


FIG. 9—GUY DERRICKS will erect the spans of the river crossing. View, showing start of work on Pier 5, was taken shortly before the derrick was jumped to a track on the top chords of the trusses.

structure. Although large in number, the individual foundations are not of great size, being low piers on shallow spread footings on wood piles. Concrete for these piers and footings is being distributed by pumping, in the hope of overcoming the distribution problem growing out of the fact that each approach extends inland about 2 miles.

Steel erection on the north viaduct is completed, and work on the south viaduct is under way. On each, erection is begun at the river end, where the materials are delivered by barge, and is continued inland, using a traveler on the viaduct. Steel is moved inland on a construction railroad parallel to the viaduct.

Steel erection for the river crossing began about the middle of March at Pier 5. Fig. 9, from a photograph taken on March 27, shows the first panel of steel in place. As is indicated by the picture, the guy-derrick erection method, previously used on the bridges at Louisville, Ky., (*ENR*, Aug. 28, 1930, p. 318) and at Evansville, Ind., among others, will be utilized on the New Orleans Bridge. With the first panel of steel in place the guy derrick was jumped to the top chord for the remainder of the erection of the four deck truss spans.

As soon as Piers 1 and 2 are completed, erection can begin on the cantilever and anchor arm spans. Guy derricks will be set up, and erection will continue both ways simultaneously, balanced about these piers.

Modjeski, Masters & Case are designing and supervising engineers. Moran & Proctor are consulting engineers on the foundations. C. Glennon Melville is resident engineer at the bridge. The contract for the substructure of the main river crossing is being executed by Siems-Helmers, Inc., St. Paul, under the direction of Nick F. Helmers, vice-president. J. M. Kellogg is general manager on this contract, C. E. Ryan superintendent, and J. H. Levy resident engineer. The substructure contract on the viaducts is held by the MacDonald Engineering Co. The superstructure contract on the approaches is held by the McClintic-Marshall Corp., and the American Bridge Co. has the contract for the main river spans.

Low-Heat Cement Specifications of Tennessee Valley Authority

SPECIFICATIONS for a portland cement of relatively low heat evolution, and also for a cement classified as a "modified normal portland cement," were prepared and used by the Tennessee Valley Authoritty for the purchase of the first order of 315,000 bbl. of cement to be used in the construction of the Norris and the General Joe Wheeler dams. The specification requirements included restriction as to the composition of the cement by compounds, fineness measured in terms of surface area per gram, a time of 60 min. for initial set, compressive strength of standard mortar specimens of 1,000 and 2,000 lb. per sq.in. (7 and 28 days) for the low-heat cement, and 1,500 and 2,500 lb. per sq.in. for the modified portland. The tensile-strength test is eliminated.

The specifications did not include any requirement for the heat of hydration. The concrete volume in the structures to be built is not unusual, as compared with Boulder Dam, and it is assumed that the requirements set forth for compound composition and fineness will be sufficient to produce a cement with a heat of hydration not exceeding the desirable limit.

The principal characteristics of the TVA specifications are tabulated, and, for the purpose of comparison, the table also includes the corresponding characteristics of the last Boulder Dam cement specifications (No. 566, March, 1934) and the original Boulder Dam cement specifications.

It will be noted from the table that the low-heat (type A) specification of the TVA is similar in most respects to the last specification for Boulder Dam cement, but the latter varies in several minor requirements from the original Boulder Dam specifications (*ENR*, Nov. 10, 1932, p. 558), which represented the first attempt to specify a cement designed particularly for mass concrete.

TVA AND BOULDER DAM CEMENT SPECIFICATIONS COMPARED

	Tennessee Valley Authority		Boulder Dam (Bureau of Reclamation)	
	Type A — Relatively Low Heat	Type B — Modified Portland	Spec. 566 March 26, 1934	Original (Tentative)*
Chemical Composition				
Loss on ignition, per cent	3.0	3.0	3.0	3.0
Insoluble residue, per cent	0.85	0.85	0.85	0.5
SO_3 per cent	2.0	2.0	2.0	2.0
Mg O per cent	5.0	5.0	5.0	4.5
Compound Composition				
Tricalcium silicate (max.)	35	35 to 55	40	...
Dicalcium silicate (max.)	60	Not spec.	55	60
Tricalcium aluminate (max.)	7	8	7	5
Tetracal. aluminoferrite	20	Not spec.	20	...
Fineness, sq.cm./gr.	1,700–2,300	1,600–2,200	1,700–2,300	1,300–1,700
Time of set (initial)	60 min.	60 min.	60 min.	105 min.
Compressive strength (1:3 mortar lb./sq.in.) 7 days	1,000	1,500	1,000	1,000
Compressive strength (1:3 mortar lb./sq.in.) 28 days	2,000	2,500	2,000	2,400
Heat of hydration (calories/gram) 7 days	Not specified		65	60
Heat of hydration (calories/gram) 28 days	Not specified		75	70

*These tentative specifications were reviewed in *ENR*, Nov. 10, 1932, p. 558.

Capacity of Outlets for Erosion-Control Dams

Hydraulic characteristics and discharge capacities determined for drop-inlet pipe and box culverts used as outlets for small dams built on soil-saving projects

By C. E. Ramser
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EMPHASIS developing on erosion-control work, and the resulting increase in the number of small check dams built in gulleys to flatten out flood peaks and catch debris, directs attention to the hydraulic characteristics of the culvert type of outlets that are usually provided for these structures. The capacity of these outlets is based on the relatively simple hydraulic relation between the cross-section area and effective head, corrected for the necessary factors of entrance loss, loss at bend, and friction.

In order to facilitate the selection of the proper size of outlet, after the determination of the estimated runoff and the effect of pondage, the discharge for various sizes of both pipe and box culverts, built with the usual drop-head construction, has been computed and placed in the form of curves for rapid determination. It is believed that these data in their present form will be of assistance in carrying out the design of soil-saving or erosion-control structures.

The fundamental hydraulic principles involved in the solution of the problem are covered in any standard textbook on the subject and need not be reviewed here. The factors introduced in the preparation of the discharge curves include the effective head, considered as the theoretic velocity head, corrected for loss of head at the entrance, the loss at the bend and the loss resulting from the friction in the discharge pipe. This formula for total static head is

$$H = \frac{V^2}{2g} + \left(\frac{1}{C^2} - 1\right)\frac{V^2}{2g} + f_1\frac{LV^2}{D2g} + f_2\frac{V^2}{2g}$$

The left-hand side of the equation represents the vertical distance from the surface of the water behind the dam (arbitrarily assumed to be 1 ft. lower than the crest) measured down to the inside of the pipe at the top of the outlet end (Fig. 1).

Transposing this equation to secure quantity in second-feet, it becomes

$$Q = aV = a\sqrt{\frac{2gH}{1 + \left(\frac{1}{C^2} - 1\right) + f_1\frac{L}{D} + f_2}}$$

In this equation Q = discharge in cubic feet per second; a = area of the pipe or box in square feet; V = velocity in feet per second; H = total static head in feet, as explained; L = length of pipe in feet; D = diameter of pipe in feet; g = acceleration due to gravity; C = entrance-loss coefficient—[Values for this coefficient were taken from Fig. 84 in Schroder and Dawson's "Hydraulics," 1927]; f_1 = loss of head due to friction in pipe—[Values for this coefficient, based on fairly smooth pipe, were taken from Fig. 107 in Schroder and Dawson's "Hydraulics," 1927]; f_2 = loss of head at bend. [Values for this coefficient, based on cast-iron pipe, were taken from table 80 in King's "Handbook of Hydraulics," second edition.]

If physical conditions at the individual sites indicate that during the period of maximum discharge the outlet end of the culvert will be submerged, the probable elevation of the backwater surface should be determined, and the difference between this elevation and the water surface on the upstream side of the dam should be used as the total effective head on the culvert.

The computations forming the basis of the data represented by the curves were based on the drop-inlet culvert design and installation in the typical small earthfill dam shown in Fig. 1. The results are not directly applicable to other culvert installations where the length of pipe, curvature and entrance conditions are different. The entrance design, as used in the calculations, has a rounded lip, and the right-angle bend is considered to have a radius to the inside of the bend equal to the diameter of the pipe. If bell-mouthed pipes are used for the inlet, they should be rounded out with concrete. The friction factors used

Table of Variables

H+D	H_c	S	A	B	W
10'-0"	11'-6"	1'-6"	1'-0"	9'-6"	44'-0"
15'-0"	17'-3"	2'-3"	1'-6"	12'-0"	64'-0"
20'-0"	23'-0"	3'-0"	2'-0"	14'-0"	84'-0"
25'-0"	29'-0"	4'-0"	2'-6"	16'-0"	104'-0"

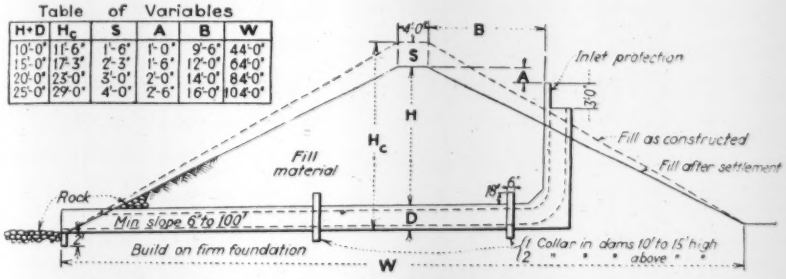


FIG. 1—INSTALLATION and dimensions of drop-inlet culvert in small erosion control dams. Discharge capacities of this type of outlet are indicated in Fig. 2.

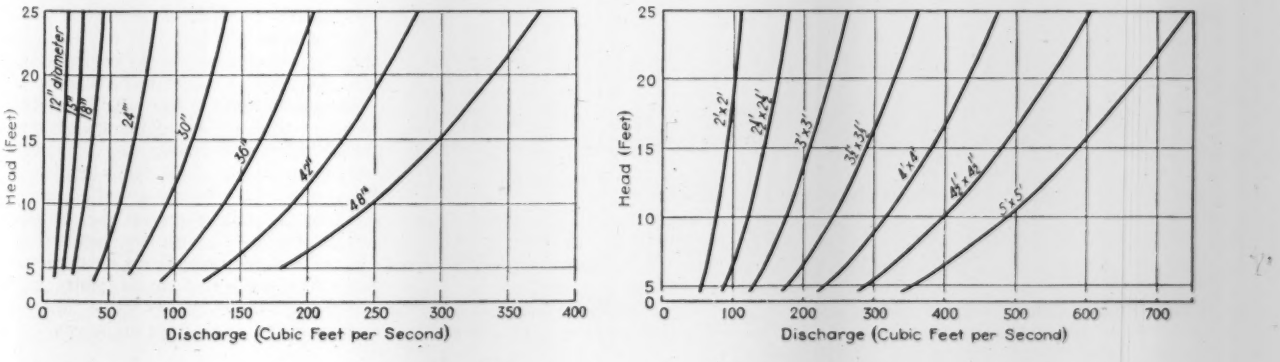


FIG. 2—DISCHARGE CAPACITIES for drop-inlet culverts: smooth pipe culverts are shown at left and box culverts at right.

in the preparation of the curves are for fairly smooth pipe, but the results will be sufficiently accurate for practical purposes if the pipe is either concrete or vitrified material. Discharge capacities for pipe culverts from 12 to 48 in. in diameter under heads varying from 5 to 25 ft. are shown in Fig. 2, left.

If corrugated pipe is used to form the outlet culvert, the discharge capacities as shown in the curves need to be reduced. The ratios of discharge capacity for smooth and corrugated culverts are tabulated in the following figures.

Size of Pipe, In.	Length = 100 Ft. Head = 5 Ft. Discharge in Cubic Ft. Per Sec. Corrugated Pipe	Vitrified Pipe	Ratio of Discharges
12	4.12	7.85	.525
15	7.23	13.20	.548
18	11.40	20.00	.570
24	23.30	38.10	.612
30	40.30	62.10	.649
36	62.30	91.50	.681
48	123.00	165.00	.745

Data from Bulletin I "The Flow of Water Through Culverts" University of Iowa.

To determine the capacity for a corrugated pipe, the discharge figure should be taken first from Fig. 2 and then corrected by the factor indicated in the table. The result will be a figure slightly less than the actual capacity of the corrugated pipe because of the assumption that the loss in head in both pipes at the bend will be the same.

In the larger-sized erosion-control dams, monolithic-concrete box culverts are often used. The discharge capacities for such square outlets are indicated in Fig. 2, right.

Sewage Plant Survey—IV

Data from Aurora, Ill.

THE FOLLOWING ARTICLE is the fourth of a series presenting in brief form the salient design and performance characteristics of American sewage plants. Articles already published have presented data from the following cities: Decatur, Ill., March 29, 1934, p. 409; Cleveland, Ohio, April 12, 1934, p. 480; Schenectady, N. Y., April 26, 1934, p. 527.

THROUGH the operation of screen, grit chamber, sedimentation tanks and trickling filters, the sewage of Aurora, Ill., in 1933 was reduced in biochemical oxygen demand from 123 to 23 p.p.m., or more than 81 per cent, before its discharge into the Fox River. There are tabulated below the principal design features of the plant and the average performance data for the year 1933.

Sewage in Aurora is collected by a combined sewer system. The treatment plant was designed by Alvord, Burdick and Howson in 1926 to care for a population of 67,000. Construction was complete, and operation was begun in September, 1929. In 1930 an incinerator was installed, to dispose of the screenings through the burning of sludge gas. A second storm overflow, to remove screenings and grit before discharge to the river, was added in 1932. The total cost of the plant to date is estimated at $675,000.

The plant effluent is discharged into the Fox River. That stream, at the point of effluent discharge, has an average flow of 1,300 sec.-ft.; its range of flow is wide, from 100 to 3,950 sec.-ft. Oxygen resources of the river averaged 71,000 lb. daily in 1933. No water is taken from it below the plant.

In the accompanying table the flows reported were measured by a venturi meter. Analytical results refer to 24-hour composite samples, annual average.

In the operation of the sedimentation units, two tanks only are used at a time. For half the year the settled effluent is applied to the trickling filters; during the other half it is discharged directly into the river.

The sludge-digestion tanks are equipped for mechanical agitation. Iron pipe is used for the hot-water coils. Supernatant liquor is returned to the settling-tank influent.

The data for this article have been made available by Walter A. Sperry, superintendent in charge of the plant.

SEWAGE-PLANT PERFORMANCE DATA, AURORA, ILL.

GENERAL DATA

Population, 1934	46,590
Population served, 1933	47,000
Rated capacity of plant, m.g.d. dry weather	6.5
Sewage flow	
Average m.g.d.	6.6
Maximum day, m.g.d.	9.8

SEWAGE-TREATMENT UNITS

Fine Screens

Number of units	1
Width of opening, in.	¼
Method of cleaning	Automatic, float-controlled
Loss of head, average, ft.	0.3-0.5

Grit Chambers

Number of units	1
Plan dimensions, each unit, ft.	26x26
Operating depth, including grit space, ft.	1.75-2.75
Depth allotted to grit space, ft.	0.5
Method of cleaning	revolving scrapers
Frequency of cleaning	continuous during storm

Primary Sedimentation Tanks

Number of units	4
Plan dimensions, each unit, ft.	50x50
Operating depth, including sludge space, ft.	10
Provisions for sludge removal	revolving scrapers
Frequency of operation	continuous
Sewage flow, each unit, m.g.d.	3.3
Detention period at maximum flow, each unit, hr.	1.3

Trickling Filters

Number of units	1 (4 sections)
Plan dimensions each unit, ft.	586x274
Sewage flow, all units, m.g.d.	6.6
Type of filter material	crushed limestone
Depth of filter material, ft.	6
Type of distributing system	spray nozzle
Type of underdrain system	glazed title

SLUDGE DISPOSAL

Sludge Digestion Tanks

Number of units	3
Plan dimensions, each unit, ft.	50x50
Depth, each unit, ft.	16½
Capacity, each unit, cu.ft.	41,640
Depth of earth cover, ft.	1½
Temperature maintained, deg. F.	85

Sludge-Drying Beds

Number of units	10
Length, each unit, ft.	125
Width, each unit, ft.	40
Depth of sand, in.	2
Depth of sludge applied, in.	12-14

ANALYTICAL RESULTS

	Settleable Solids, (2 hr.), c.c. per liter	Suspended Solids, p.p.m.	Total Solids, p.p.m.	Five-Day B.O.D. p.p.m.
Raw sewage	2.9	130	920	123
Settling-tank effluent	0.4	67	850	86
Trickling-filter effluent	0.3	34	...	23

SCREENINGS, GRIT AND SLUDGE

	Volume, Cu.Ft. Per M.G.	Dry Solids Per Cent	Volatile Solids Per Cent	pH	Disposal
Screenings	1.3	15	...	...	Incineration.
Grit	2.3	60	38.9	...	Fill.
Settling-tank sludge	168.5	5.5	67	7.5	To digestion tanks.
Digested sludge	45.8	8.9	43.4	7.3	To drying beds.
Dried sludge	16	55-90	41-43	...	City parks; sold.

Concrete in Alkali Waters

Study of the action of alkali water on cement and concrete was continued last year by the National Research Council of Canada in cooperation with the Canada Cement Co. and the University of Saskatchewan. The cement company has already begun the manufacture of an alkali-resistant cement at its plant at Exshaw, Alberta. The cement produced there has now been used in some large structures in districts where alkali action is appreciable.

The laboratory work carried out at the National Research Laboratories at Ottawa during the last year has included further tests of the efficiency of various methods of preventing the deterioration of concrete in alkali soils and also a study of the effect of the chemical nature of aggregates on the properties of concrete. Laboratory measurements have been continued on test pieces of concrete subjected to sulphate action. Some of these pieces have now been exposed for more than eight years.

Designing Tunnel Ventilation for Construction Use

Most efficient and economical size of equipment units can be determined with aid of graphs and formulas—Plan used in designing plant for 193,000 ft. of Colorado River aqueduct tunnels

By G. F. Maughmer
General Electric Co., Los Angeles, Calif.

THE VENTILATION of tunnels during construction has progressed in the past few years from a haphazard and inefficient operation to a scientific and carefully designed procedure. Reasons for the advances made in the field of ventilation can be attributed to the constantly increasing length of headings being driven, the general improvement in tunnel-driving procedure and equipment and the increasing attention paid to condition of working atmosphere, from the standpoints of both health and working efficiency.

Economic and efficient ventilation of modern long headings is one of the most difficult problems facing the tunnel builder. In the following is presented a quick and satisfactory method of determining cost and characteristics of a tunnel ventilation system. This method was followed in designing the ventilation plant for some 193,000 ft. of tunnels and adits being driven on the Colorado River aqueduct in southern California.

This study is only intended to cover the problem of supplying a sufficient quantity of fresh air to the face in the most efficient and economical manner. The major portion of the capital investment and operating expense involved in tunnel ventilation is ordinarily to that end. From the standpoint of operating efficiency, careful attention must be given to several other phases of the problems such as face blowers, dust control, etc. These vary with local conditions and should be given careful study after work has started, in order to arrive at the best possible operating method. No attempt to analyze them will be made here.

Alternative methods

Three general methods of tunnel ventilation through a single pipe are in use today. In every case a complete circulation of air must be established from the portal of the tunnel to the working face and back to the portal. The movement must be in one direction through the pipe and in the opposite direction through the tunnel. The friction of the air moving through the pipe and tunnel will build up a back pressure that must be overcome by the compressor equipment. The three methods are: continuous blowing, continuous exhaust and a combination of blowing and exhaust.

In the continuous-blowing method the fresh air is constantly forced through the ventilation pipe, replacing the dust, smoke and foul air in the heading and forcing them out through the tunnel to the portal. It has the advantage of simplicity of equipment and operation, but it also has the disadvantage of keeping the smoke and dust in the tunnel from face to portal. Dilution of the smoke and dust with air takes place gradually as the portal is reached, but visibility is reduced, surveying operations are handicapped and safety is jeopardized.

In the second method—that of continuous exhaust—the foul air, smoke and dust are drawn out through the pipe and replaced by fresh air moving in through the tunnel. This method has the advantage of supplying clean air to the tunnel at all times. Smoke and dust may be exhausted at a maximum rate immediately after a shot is fired and until the face is clear, and then, in order to conserve power, the volume of air moved may be reduced considerably until time to shoot again. In a warm damp tunnel the incoming air becomes saturated with moisture before it reaches the face, creating unpleasant working conditions. During drilling operations exhaust air from the drills replaces some of the air that would otherwise be drawn in through the tunnel, decreasing the amount of fresh air supplied.

The third method, a combination of the first two, has been used with marked success and is gaining in favor with many practical tunnel men. Immediately after a shot is fired, the equipment is operated at a maximum capacity to exhaust smoke and dust as rapidly as possible, usually requiring 5 to 15 min. After the smoke and dust have been cleared away, the procedure is reversed and fresh air is blown in through the pipe, usually at a reduced rate. Recent developments have greatly simplified the equipment and operation required by this method. It combines the advantages of the others, and, in addition, can be operated permanently as any one of the three methods if occasion demands.

Volume of air required

One of the most difficult problems confronting the ventilating engineer is the determination of the amount of air to be supplied. From the standpoint of the contractor or the man who is paying the bill, the correct way to ventilate a tunnel during construction is the most economical way. If the quantity determined upon is greater than the most economical volume, the cost of equipment and power will be excessive. If the volume selected is too low, undesirable working conditions result in inefficiency and higher labor cost.

Operators are realizing more and more the value of efficient and adequate ventilation. Workmen provided with fresh air are more alert, more capable and more willing. As a result, better ventilation at higher costs is being installed, paying dividends in increased job efficiency by the time the work is finished. Some localities have laws covering conditions of ventilation for tunnel work. These laws do not necessarily correspond with the minimum quantities based on economic laws. Unfortunately, few accurate data on these economic laws are available at the present time. The various factors and laws are intangible and are not easily measured but might some day be evaluated through research. Until such work is done and information is made available, the ventilating engineer must rely upon past experience and good judgment in determining the correct quantities of air for each project under consideration.

Pipe size

Once the quantity of air to be supplied is determined, the next step is to select the correct size of pipe. As the pipe size determines the pressure required for a given quantity of air, it fixes pipe gage and cost, compressor size and cost, and power consumption. Physical or other limitations may modify the final selection of pipe size, but the economic consideration should be the starting point.

To discuss adequately the selection of pipe size, compressor capacity and other details of a ventilation system, the design of a typical plant will be presented in the following. These assumptions are made at the start: tunnel section, 300 sq.ft. rough cut; length of heading, 18,000 ft., running straight from portal to the holing-through point; driving method, three rounds per 24 hours; air requirement, 6,000 cu.ft. per min. (c.f.m.) free air minimum to be exhausted from the face for 30 min. after each shot and 3,000 c.f.m. free air minimum to be blown to the face at all other times; power cost, 1.5c. per kw.-hr.; barometer, 14 lb. per sq.in.; average temperature of air, 70 deg. F.

To exhaust 6,000 c.f.m. free air from the face through 18,000 ft. of pipe, the ventilating compressor must create a suction. The pipe will tend to collapse due to this suction, and the collapsing stress will determine its physical requirements. Under normal conditions of operation the suction and collapsing force will be a maximum at the compressor and will decrease along the pipe toward the open end. Should the pipe become plugged anywhere in the line,

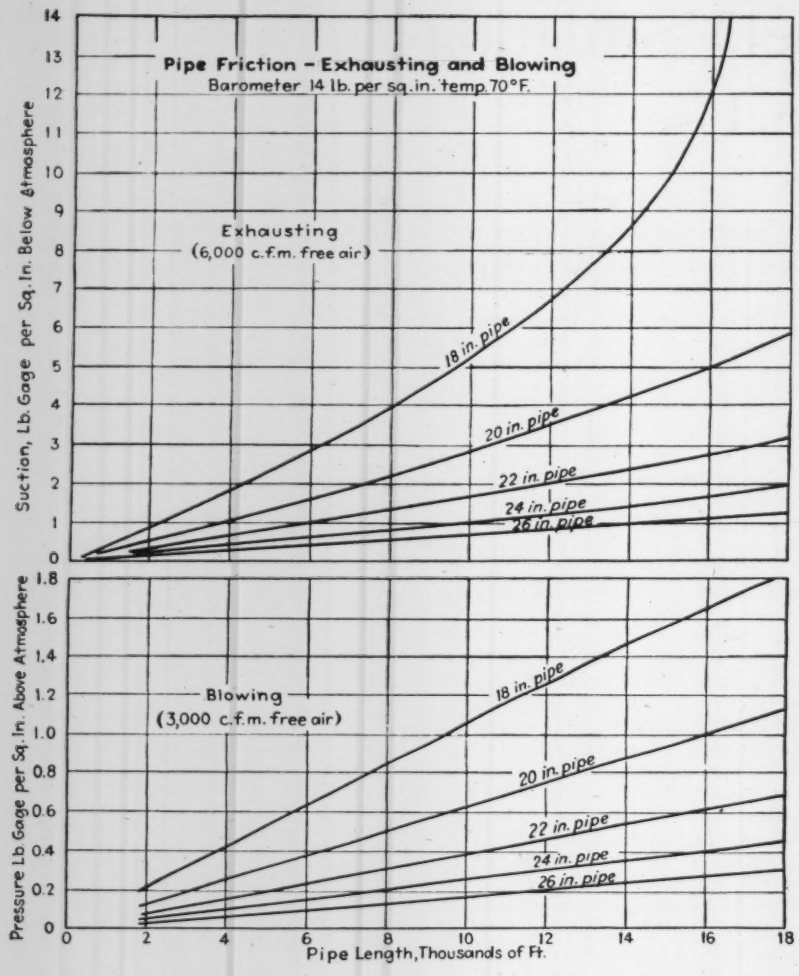


FIG. 1—PIPE FRICTION in ventilation systems, exhausting and blowing, for various sizes of pipe up to 18,000 ft. in length. Barometer, 14 lb. per sq.in.; temperature, 70 deg. F.

maximum suction will be developed from that point to the machine. If centrifugal compressors are used, this suction will not exceed the normal exhausting suction, and relief valves will not be required, provided the entire length of pipe is of uniform section. In some cases it might be economical to reduce the gage of steel pipe at one or more intermediate points, and it would be necessary to install relief valves at each point of reduction, in order to afford protection against collapse.

The first step in finding the economic pipe size is the determination of the maximum suction required for the several pipe sizes to be considered. This can be done as accurately as required by the formula:

$$D = P_i\left(1 - \sqrt{1 - 16.8SQ_i^2 f\frac{L}{T_i d^5}}\right)$$

where

D = friction drop or suction, lb. per sq.in.

Q_i = Volume entering pipe or free air, cu.ft. per min.

P_i = pressure of air entering pipe, lb. per sq.in. abs.

T_i = temperature of air entering pipe, deg. F., abs.

L = length of pipe, ft.

d = inside diameter of pipe, in.

f = coefficient of friction (use 0.0001)

S = specific gravity of gas referred to air (use 1.0)

The economic pipe size is assumed to lie between 18 and 26 in. in diameter. The upper chart in Fig. 1 shows the suction gradient for various sizes of pipe from 18 to 26 in. for lengths up to 18,000 ft., based on exhausting 6,000 c.f.m. free air. Welded steel pipe will be used, and from Table I the steel gage required to withstand collapsing pressures can be determined. There are a number of formulas for calculatnig collapsing strength of steel pipe, but for this study the formula for thin-walled casing as published by Prof. Harold A. Thomas in the American Petroleum Institute *Proceedings*, Vol. 5, No. 75, p. 79, will be used:

TABLE I — CHARACTERISTICS AND CO[illegible] OF STEEL PIPE

Pipe Dia., In.	Net Collapsing Pressure, Lb. Per Sq.In.	Net Safe Pressure, Lb. Per Sq.In.	Weight Per Ft. Lb.	Co[illegible] Per [illegible]
10-Gage				
18	23.8	9.50	31.0	$1 [illegible]
20	17.25	6.90	34.5	1 [illegible]
22	12.9	5.15	38.0	1 [illegible]
24	10.0	4.00	41.0	2 [illegible]
26	7.0	3.16	45.0	2 [illegible]
12-gage:				
18	11.2	4.48	24.0	1 [illegible]
20	8.15	3.26	27.0	1 [illegible]
22	6.1	2.44	29.5	1 [illegible]
24	4.7	1.88	32.0	1 [illegible]
26	3.74	1.50	34.5	2 [illegible]
14-Gage				
18	4.06	1.62	18.0	[illegible]
20	2.97	1.19	20.0	1 [illegible]
22	2.20	.88	22.0	1 [illegible]
24	1.73	.69	24.0	1 [illegible]
26	1.37	.55	26.0	1 [illegible]

$$P = \frac{2.25\left(f\frac{t}{D}\right)^3}{(.056f - 574)^2}$$

where

P = net pressure which will cause the pipe to collapse, lb. per sq.in. (external pressure minus internal pressure, lb. per sq.in. abs.)

f = yield point of steel in lb. per sq.in. (assume 35,000)

$\frac{t}{D}$ = $\frac{\text{wall thickness, in.}}{\text{outside diameter, in.}}$

Net collapsing pressures and the suggested safe loading based on a factor of safety of 2½ for pipe sizes from 18 to 26 in., 10 to 14 gage, are given in Table I. This table also gives the price and weight per foot for each size. Prices include a suitable type of joint, which is airtight if applied with reasonable care. The prices shown are f.o.b. the portal for the particular job under consideration.

From the curves in Fig. 1 and the data in Table I, the most economical arrangement of pipe for each of the five sizes under consideration can be determined. For example, the net collapsing pressure or suction on the 22-in. pipe will be a maximum of 3.2 lb. per sq.in. at the compressors, as shown in Fig. 1. According to Table I, this requires 10-gage 22-in. pipe to come within the safe operating range. The next lighter or 12-gage 22-in. pipe can safely operate under suction up to 2.44 lb. per sq.in. According to Fig. 1, this pressure is reached at 14,000 ft. from the open end of the pipe, which is the zero suction point. Therefore, 4,000 ft. of 10-gage 22-in. pipe will be required. This same method of study shows that 9,000 ft. of 12-gage and 5,000 ft. of 14-gage pipe also might be used. Each size of pipe can be investigated in the same manner and the quantities of each weight of pipe determined. From these results and the prices shown in Table I, the total cost for pipe of each size can be calculated. These data are set up in Table II. The cost of pipe installation will not vary

TABLE II — TOTAL COST OF VARIOUS SIZES AND LENGTH OF PIPE FOR 18,000-FT. TUNNEL

Pipe Dia.	10-Gage Ft.	10-Gage Cost	12-Gage Ft.	12-Gage Cost	14-Gage Ft.	14-Gage Cost	Total Cost
18*	0	0	18,000	$22,500	0	0	$22,500
20	8,000	$13,200	6,000	8,100	4,000	$4,280	25,580
22	4,000	7,200	9,000	13,320	5,000	5,800	26,320
24	2,000	4,400	16,000	28,800	0†	0	33,200
26	0	0	18,000	38,700	0†	0	38,700

*If only one compressor is used for 18,000 ft. of pipe, the suction required will be so great that it is advisable to use one compressor at the adit and a booster at 9,000 ft. It will not be practicable to reduce the pipe gage.
†The use of 14-gage, 24-in. and 26-in. pipe is not practicable in this type.

TABLE III — TOTAL POWER COSTS FOR VARIOUS SIZES OF PIPE

Pipe Dia., In.	Exhausting, 1,800 Hr. Max.Kw. Input	Exhausting, 1,800 Hr. Max.Kw. × Time	Exhausting, 1,800 Hr. Actual Kw.-Hr.†	Blowing, 27,000 Hr. Max.Kw. Input	Blowing, 27,000 Hr. Max.Kw. × Time	Blowing, 27,000 Hr. Actual Kw.-Hr.†	Total Actual Kw.-Hr.	Total Power Cost
18	*390.8	704,000	440,000	49.70	1,340,000	837,500	1,277,500	$19,162.00
20	268.5	484,000	302,500	30.60	825,000	515,625	818,125	12,272.00
22	123.4	222,000	138,750	19.00	513,000	320,625	459,375	6,890.00
24	71.6	129,000	80,525	12.50	337,000	210,625	291,150	4,367.00
26	45.6	82,100	51,312	7.80	210,000	131,250	182,562	2,738.00

*Total input to two compressors, one at portal and one at 9,000 ft. (See footnote Table II).
†Actual kw.-hr = 62.5 per cent of maximum kw.-hr. × time.
In calculating the kw. input to the motor from the theoretical air hp., it is necessary to take into consideration both the motor and compressor efficiency.

greatly with the diameter and may be disregarded for the present purposes.

Having determined the relative cost of the various sizes of pipe, the next step is to find the cost of power for providing ventilation during the entire period of construction for the various sizes of pipe under consideration. The maximum kw. input to the compressor motors for each size of pipe can be calculated, both for blowing and exhausting, and power costs can be determined which will be close enough for preliminary comparative purposes. The maximum pressure required to blow 3,000 c.f.m. free air through the various sizes of pipe is given in the lower chart of Fig. 1. By using the method of calculating horsepower as set forth in the A.S.M.E. standards, the kw. input to the motor for the various sizes, corrected for machine efficiency, can be determined. The formula for normal air is as follows:

$$P_e = 0.01542 P_i Q_i Y$$

where P_e = air horsepower for adiabatic compression and delivery.
P_i = abs. total inlet pressure, lb. per sq.in.
Q_i = inlet volume, cu.ft. per min.
$Y = r^{0.283} - 1$ for air and diatomic gases.

where $r = \frac{P_f}{P_i}$

P_f = abs. total discharge pressure, lb. per sq.in.

The maximum kw. inputs determined by the above formula represent the conditions for the final length of pipe just before the bore is completed. If this were a constant quantity, it would be necessary only to multiply the kw. input in each case by the number of hours of operation, to determine the total kw.-hr. consumed. Such is not the case, and a different method must be employed. Assuming a construction progress rate of an average round of 5 ft. per 8-hr. shift, 3,600 rounds are required to drive 18,000 ft. of tunnel. In exhausting 30 min. and blowing 7½ hr. per round, the total time of compressor operation will amount to 1,800 hr. for exhausting and 27,000 hr. for blowing. If the volume remains constant, the kw. input at any time is determined by the pressure or suction required, and this in turn is determined by the pipe length. Therefore, the average kw. input should be less than the maximum.

TABLE IV — TOTAL COST OF POWER, PIPE AND COMPRESSORS FOR VARIOUS SIZES OF PIPE

Pipe Dia., In.	Compressor Cost	Pipe Cost	Power Cost	Total Cost
18	$12,500	$22,500	$19,162	$54,162
20	7,500	25,580	12,272	45,352
22	4,500	26,320	6,890	37,710
24	3,000	33,200	4,367	40,567
26	2,500	38,700	2,738	43,938

The centrifugal compressor is inherently a constant pressure machine, but, as shown later, the equipment may be modified to meet the requirements of varying pressure or pipe length involved in tunnel ventilation. For preliminary study it is assumed that the maximum pressure can be reached in four equal steps. According to Fig. 1, the pressure drop through the pipe is approximately proportional to the pipe length for the lower values of pressure. As this is especially true for pressures in the practical and economic range, it is sufficiently accurate to assume that the pressure drop is directly proportional to the pipe length for preliminary calculations in determining pipe size. Such being the case, the job will be started with zero pipe length and a compressor combination capable of generating 25 per cent of the maximum final pressure required. This pressure will be sufficient until 25 per cent of the tunnel has been driven and 25 per cent of the pipe installed. When that point is reached, it will be necessary to increase the pressure to the next higher step, or 50 per cent of the ultimate. This will be adequate up to 50 per cent pipe length. Following through, 75 per cent pressure will be used from 50 to 75 per cent of the pipe length and 100 per cent pressure from 75 per cent pipe length to the end of the job.

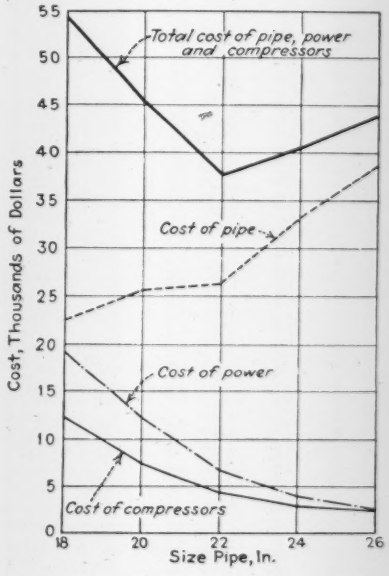


FIG. 2—TOTAL COST of power, pipe and compressor equipment for an 18,000-ft. tunnel for various sizes of pipe.

The kw. input to the driving motors is assumed to increase directly with the pressure. As the ventilation of the tunnel will be carried on in four pressure steps, the kw. input will be one-quarter maximum for the first 25 per cent of time, one-half maximum for the second 25 per cent of time, three-quarters maximum for the third 25 per cent of the time, and maximum for the fourth or last quarter of time. Expressed in percentage of kw.-hr. as determined by total time, multiplied by maximum kw. input, this will be:

$$(\tfrac{1}{4}\times\tfrac{1}{4}) + (\tfrac{1}{2}\times\tfrac{1}{4}) + (\tfrac{3}{4}\times\tfrac{1}{4}) + (1\times\tfrac{1}{4}) = 62.5\%$$

Using a power cost of 1.5 c. per kw.-hr., Table III gives the power cost for each size of pipe considered.

The remaining item of cost will be the compressor equipment. The plan of operation, to be described later, requires two duplicate compressors, each capable of handling the total volumes at one-half the maximum pressure. In Table IV is shown the total estimated cost of the compressor equipment with necessary auxiliaries. This table also shows the cost of pipe and power, and the total over-all cost of ventilation for the job exclusive of installation, attendance and maintenance, which may be considered as constant with these pipe sizes. In Fig. 2 these results are plotted and indicate that 22-in.-dia. pipe is the most economical size.

Equipment and operation

To secure the lowest possible over-all cost of ventilation, the selection and operation of equipment must be such that a desired quantity of 6,000 and 3,000 c.f.m. free air exhausted from and blown into the tunnel, respectively, can be maintained. The desired condition can be approached very closely by using two centrifugal compressors with a rated capacity such that the two, when operating in series, will exhaust the specified quantity of free air through the maximum length of pipe. This represents the most severe requirement of the whole job and fixes the volumetric capacity

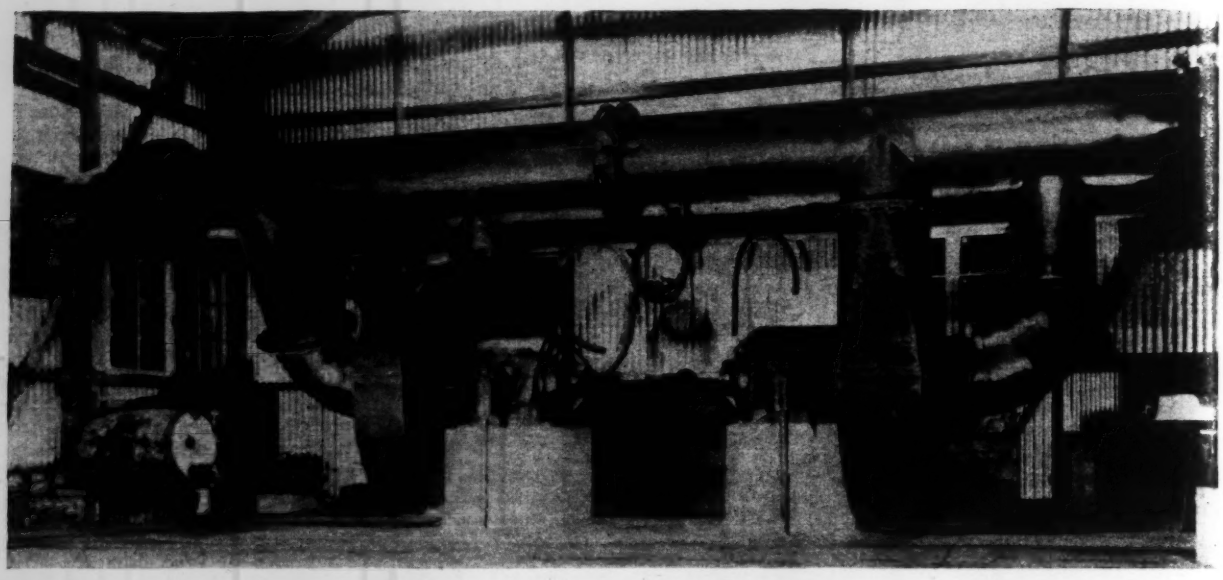


FIG. 3—DUAL-COMPRESSOR arrangement on one of Colorado River aqueduct tunnels. This is a view of actual set-up as shown in diagram Fig. 4.

and pressure rating of the machines.

At the start of excavation one machine will be installed without modification, but the other will be used at first with a reduced-diameter impeller capable of handling maximum volume at only one-half of the machine's normal pressure (one-fourth total ultimate pressure required). Each machine will be driven by a two-speed motor. The two machines thus installed will develop three-quarters of the ultimate pressure when operating in series and will be suitable for operation without change until the work is 75 per cent complete. It will then be necessary to replace the reduced-diameter impeller on the one machine with a full size impeller, a simple procedure.

The most severe condition of operation is when the machines are exhausting 6,000 c.f.m. free air, in the maximum length of pipe. During the exhausting period the air expands as it passes through the pipe due to suction of the compressor, and its maximum volume is reached at the inlet of the compressor. Therefore, the volumetric capacity of the compressor must be considerably greater than 6,000 c.f.m. In the centrifugal machine this is known as the "inlet volume" rating, which corresponds to the "displacement volume" plus slip volume rating in the positive displacement type of equipment. Fig. 9 shows the relation between free air and inlet volume for various suctions. The data from which this curve is plotted were obtained by calculating the inlet volume, taking the corresponding free-air volume as 100 per cent at 14 lb. per sq.in. absolute and assuming constant temperature, from the formula:

$$Q_f : Q_i = P_i : P_f$$

where Q_f and P_f = free-air volume and abs. pressure.

Q_i and P_i = inlet volume and abs. pressure.

The installation of two machines as suggested permits a very flexible operation as regards variations in pressure and volume. Either of the machines can be operated alone, or the two can be run

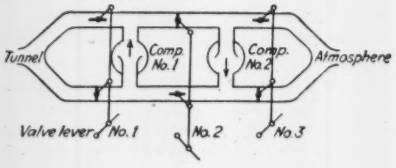


FIG. 4—DIAGRAM of two-compressor set-up permitting various combinations of pressures for economical operation for various stages of construction progress.

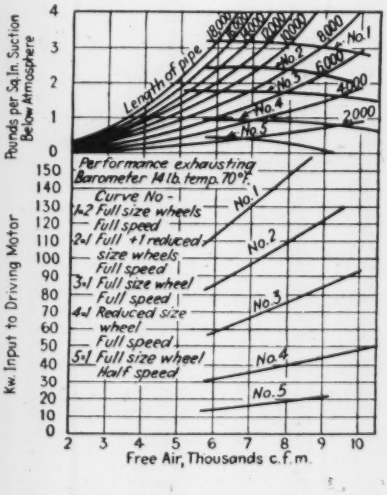


FIG. 5—CHARACTERISTICS of dual-compressor arrangement with various combinations of impellers, exhausting.

in series, either or both at full or half speed, and, during the life of the job, a change in pressure characteristic of one machine can be brought about by a change of impellers. These characteristics are shown in Figs. 5 and 7.

Control apparatus

The control for the two-speed motors is simple. A manually operated combination, full-voltage starting and pole-changing switch, is available. This switch has a single handle with three positions: full speed, half speed and off. Undervoltage protection and no-voltage release are provided in both running positions. Magnetic control can be secured if preferred.

As shown by the curves (Figs. 5 and 7), the kw. input to the motor is fairly proportional to the free-air volume for any given wheel size, motor speed and operating condition. It is possible to calibrate an ammeter in c.f.m. free air for each centrifugal compressor and use it as a guide in operating the equipment. This makes a very inexpensive and reasonably accurate flow-measuring device. The ammeter can be calibrated in amperes as well as c.f.m. and thus serves a double purpose.

Changing blowing to exhaust

The method of ventilation requires that the same compressors exhaust or blow through the pipe as desired. A simple manifold has been designed with only three valve-operating levers that will allow either machine alone or the two in series to exhaust or blow. As shown in Fig. 4, each valve lever has but two positions. The direction of air flow through the compressors, which, of course, cannot be changed, is indicated. Changes in operating routine are required only at infrequent intervals as work progresses. With the exception of these transitions, the operator has only

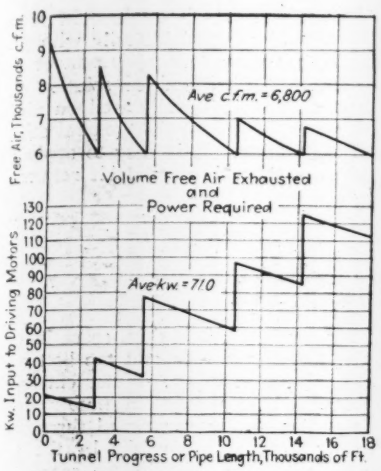

Free Air, Thousands c.f.m.
Ave c.f.m.=6,800
Volume Free Air Exhausted and Power Required
Kw. Input to Driving Motors
Ave kw.=71.0
Tunnel Progress or Pipe Length, Thousands of Ft.

FIG. 6—POWER required for exhausting various volumes of free air through various lengths of 22-in. pipe.

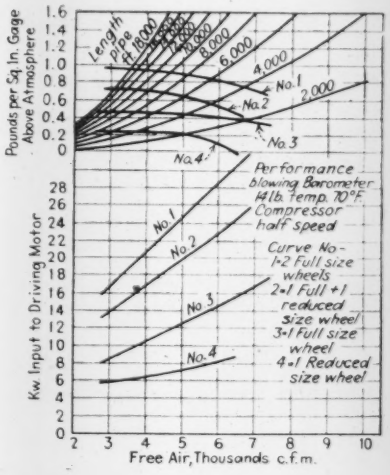


FIG. 7—CHARACTERISTICS of duel-compressor arrangement with various combinations of impellers, blowing.

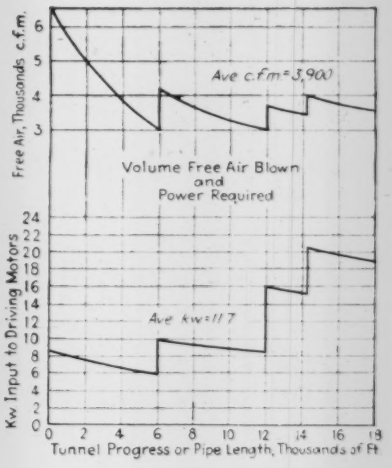

Free Air, Thousands c.f.m.
Ave c.f.m.=3,900
Volume Free Air Blown and Power Required
Kw. Input to Driving Motors
Ave kw.=111.7
Tunnel Progress or Pipe Length, Thousands of Ft.

FIG. 8—POWER required for blowing various volumes of free air through various lengths of 22-in. pipe.

two settings of control to make, one for blowing and one for exhausting. A view of two compressors operating in this manifold arrangement is shown in Fig. 3.

Operating characteristics

Once the prospective user of ventilating equipment for tunnel construction has decided on the volumes of air to be handled and has determined the economical size of pipe by the method previously outlined, the guaranteed operating characteristics of the equipment considered should be secured—to determine exactly how the equipment will perform throughout the life of the job. This determination can be done graphically in a simple and effective manner.

In the theoretical problem considered, it has been found that 22-in. pipe was the proper size to use. The ventilating equipment desired for this theoretical job must have a maximum capacity suitable for exhausting 6,000 c.f.m. free air against a friction pressure of 3.2 lb. per sq.in. below a barometric pressure of 14 lb. per sq.in. abs. and with an air temperature of 70 deg. F. This same equipment must be capable of exhausting 6,000 c.f.m. free air at lower suctions in as many steps as possible. It must also be suitable for blowing 3,000 c.f.m. free air against various pressures up to 0.686 lb. per sq.in. gage above atmospheric. Characteristics of such a ventilating unit consisting of two centrifugal compressors arranged to operate in series are shown in Figs. 5 and 7.

Fig. 5 is a composite curve showing various characteristics. From these curves can be obtained the impeller combinations, volume of free air and power input at any point in the tunnel progress. This requires some interpolation between the several pipe-length curves. Inasmuch as 6,000 c.f.m. free air is to be exhausted as a minimum, the curves to the left of this volume cannot be used. For economical reasons the lowest pressure curve of compressor characteristics that will satisfy any pipe length should be used. For example, curves Nos. 1, 2 and 3 cross the 10,000-ft. pipe-length curve, but curve No. 3 crosses nearest the 6,000 c.f.m. point and gives the lowest power input.

Volume and power input at any point in the tunnel progress is shown in Fig. 6 for exhausting and Fig. 8 for blowing. When construction is started, the pipe length will be zero, and the lowest pressure step available in the compressor plant will be used. This is curve No. 5 in. Fig. 5, one full-size wheel operating alone at half speed. This will provide 9,200 c.f.m. free air at zero lb. suction corresponding to zero length of pipe. From this same curve it is determined that 7,750 c.f.m. can be exhausted through 1,000 ft. of pipe, 6,600 c.f.m. through 2,000 ft. of pipe, and 6,000 c.f.m. through 2,800 ft. of pipe. These points determine the first section of the volume-pipe length curve on Fig. 6. From curve No. 4, Fig. 5, 2,800 ft. of pipe length shows 8,500 c.f.m. Follow this curve back to 6,000 c.f.m. to plot the second section of the curve on Fig. 6; the process repeated completes the curve to 18,000 ft. The corresponding power inputs are determined for each of the points from Fig. 5 and are plotted on Fig. 6 in the lower half with kw. input to driving motor as ordinate. These points determine the power input for each length pipe.

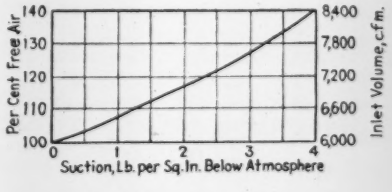


FIG. 9—INLET VOLUME of air and suction pressures in percentage of free air and in cu.ft. per min., based on 6,000 c.f.m. free air and a barometric pressure of 14 lb. per sq.in.

The curves in Fig. 6 have been averaged, and it is interesting to note that the average kw. input of 71.0 multiplied by the total number of hours of exhauster operation, or 1,800, gives a power consumption of 127,800 kwh., or reasonably close to the 137,750 kwh. listed in Table III. Fig. 6 shows graphically how the changes in compressor operation, as work progresses, keep the volume near 6,000 c.f.m. and the power input near an average line through zero and maximum. By throttling, the volume could be held exactly at 6,000 c.f.m. at all times and the power consumption would decrease somewhat, but the savings would hardly warrant the trouble involved.

Corresponding characteristics for blowing operations are shown in Figs. 7 and 8. It will be noted from Fig. 6 that when 14,200 ft. of pipe have been installed, the machine with the full-size impeller operating in series with the compressor with the reduced-diameter impeller will no longer overcome pipe friction sufficiently to exhaust 6,000 c.f.m. free air. At this point in tunnel progress it will be necessary to replace the reduced-diameter wheel with a full-size impeller. This required change is also indicated in Fig. 8. While the machines as originally installed would complete the blowing cycle of the tunnel, it is necessary to make this change for exhausting requirements. This accounts for the increase in c.f.m. and power input at the 14,200-ft. point in Fig. 8 when they do not appear to be required.

The foregoing solution of a specific problem is intended to show a method which can be adapted to many different conditions. In this case the solution

involved an equipment consisting fundamentally of two centrifugal compressors. In many cases it will be found that one compressor will do the job with one or more impeller changes. Several such installations have been made on the project where this method was first used. In some cases three or even more compressors might be required. These might all be installed at the portal, or the original installation might be made at the portal and one or more subsequent installations made as boosters at the critical points as work progressed. Again the problem may involve ventilating two headings through an adit or a shaft. This has been done in several instances quite satisfactorily with practically no change in equipment or procedure. The method of solution used here will work equally well on almost any modification of this general scheme of ventilation. It is easy to apply and gives remarkably dependable results.

Unconventional Design Features in New Water-Softening Plant

Open space beneath settling basins and filters at Evansville, Wis., utilized for raw-water basin—Paddle-agitator mixing provided within cylindrical timber reaction-tube

AN UNUSUAL TYPE of mixing chamber, comprising a cylindrical timber reaction-tube containing agitator paddles, all set in a deep concrete chamber, features the new water-softening and iron-removal plant at Evansville, Wis. The layout of units, too, is unconventional in that there is a raw-water basin beneath the filters and settling basins. The plant is designed for intermittent operation, with automatic shut-down of the units when the filtered-water reservoir is full.

Evansville obtains its water from a deep well. As the water is aggressive and contains about 0.7 p.p.m. of iron, a great amount of red-water trouble has been experienced, and in 1932 an ordinance was passed directing the local water and light commission to construct an iron-removal plant. That ordinance was later modified to call further for complete softening. The city council directed, however, that the plant be built by local labor, without letting contracts for any part of the work.

The city consumes about 50 m.g. of water per year. During the summer period of maximum demand the consumption sometimes reaches 350,000 gal. per day. Under these conditions the softening plant was designed for an ultimate capacity of 700,000 gal. per day. At present it is operated at a rate of 500,000 gal. per day; it is put into operation by manual control each morning, and when the 400,000-gal. reservoir is full, the units are automatically stopped and remain out of service until the next morning.

The structure

All of the purification units are contained in a single building 45 ft. square. At the center of the structure is the mixing chamber, 12 ft. 9 in. square and 22 ft. 6 in. deep, with its four walls forming a hollow column to which the beams, floors and partition walls are framed.

Directly behind the mixing chamber there is a diversion chamber, which receives the mixed water and divides it between the two settling basins. The two settling basins, flanking the diversion chamber, are each 12 ft. 9 in. by 26 ft. 9 in.; directly adjoining them are the two filters, each 9 ft. 2 in. by 12 ft. 9 in.

The space beneath the diversion chamber, settling basins and filters—the entire substructure of the plant with the exception of the space occupied by the lower portion of the mixing chamber—forms a raw-water basin.

The walls of the mixing chamber and the rear wall of the plant carry columns that support the frame of a chemical house and an aerator tank.

Purification processes

The water is delivered to the raw-water basin by a deep-well pump, whose operation is controlled by a float switch is the basin. A baffle causes the entering water to circle completely the mixing chamber to a sump, where it is picked up by a vertical pump mounted on the gallery floor above. This pump is provided with a 7½-hp. motor and sends the water, through a rate controller mounted on the aerator floor, to the aerator tank at the rear of the plant over the diversion chamber. The aerator is of the "Aeromix" type and discharges over a baffle plate in a wooden tank on the roof. The aerated water flows through under-and-over baffles to another compartment of the same box, leaving it through a 4-in. pipe hydraucone mixer, where it receives the lime dose. From there it enters the mixing chamber.

The mixing chamber proper contains a cylindrical reaction-tube, 8 ft. in diameter and constructed of cypress staves, in the center of which is mounted a vertical shaft carrying two agitator paddles. The staves are hung from the top slab of the chamber and are 20 ft. long, leaving a 2 ft. 6-in. space beneath the end of the tube and the bottom of the mixing chamber. Water enters the reaction tube through a timber flume, passes vertically downward through it, being agitated meanwhile by the paddles, and then rises in the space surrounding the tube and flows through ports in the wall into the diversion chamber. The agitator shaft revolves at 6 r.p.m. Sodium aluminate is fed part way down the agitator shaft by a small dry feeder.

From the diversion chamber the water divides equally to the two settling basins through which it passes to the filters. At the outlet end of each basin the water is stabilized by carbon dioxide produced by an oil burner and scrubber in the house over the mixing chamber.

Each filter is 9 ft. 2 in. by 12 ft. 9 in., and is 9 ft. deep. The underdrain system consists of 2½-in. wrought-iron pipes on the under side of which are drilled ½-in. holes spaced 7½ in. apart. The pipes are placed on 12⅝-in. centers and extend through the filter wall to the gallery, where they are connected to a welded steel header. Above the pipes are laid Wagner filter blocks, which in turn support the crushed-quartz filter material. The top size of the crushed quartz is about 0.55 mm.

The filters are also provided with a surface-wash piping system, consisting of ¾-in. pipes spaced 15⅜ in. apart, supported 2 in. above the top of the sand. Into the pipes are drilled 3/32-in. holes on 6-in. centers, directed downward at an angle of 30 deg. with the horizontal. High-pressure jets from these holes agitate the sand during the washing process, pressure being applied to this system just before the washwater from beneath the bed is turned on and shut down about 1 min. before the end of the wash. The system is quite effective against mudball formation.

The washwater pump is of about 2,000-g.p.m. capacity. It receives water from the near-by storage reservoir. The pump is located on the ground floor in the gallery between the fillers.

In order to transfer water or sludge from any compartment to any other one in the plant, a 200-g.p.m. vertical centrifugal pump driven by a 5-hp. motor is mounted in the gallery on the wall of the mixing chamber and is connected by 4-in. piping to the various chambers. For inspection and cleaning the usual

operation is to empty the water from one basin to the other, in which case only one filter is operated.

Sludge-removal system

Four sludge pick-up units in the mixing chamber and four in the diversion chamber are provided. These units consist of 23-in. convex tank heads attached to 6-in. pipe, with their edges secured about ½ in. from the floor of the chamber. They are very effective in removing sludge by lowering the water level a fraction of an inch. It has been found that to open the four-sludge valves in the diversion chamber twice a week for 12 seconds each is sufficient, while the four valves in the mixing chamber are opened for about 15 sec. each before the start of operation each day. The sludge is carried into two 8-in. lines leading out of the plant above the ground floor, where they join the 12-in. vertical waste pipe from the approach channels of the filters. All sludge and waste water are discharged into the storm sewer and pass to a creek some distance from the plant.

In the floor of each settling basin and in the diversion chamber there is a plug valve that serves as a combined emergency outlet and high-level overflow. There is no means at present of removing sludge from the basins except to raise one of these valves and wash the basin down with a hose. This is found to be necessary about once every six weeks.

Automatic shutdown

When the reservoir is full, the plant is automatically shut down for the day and cannot be started again except by the operator. The various units shut down during a period of about 20 min. following the closing of the float switch in the pumping station; this switch rides on water in a well connected to the distant surface reservoir. The sequence of operations during the shutdown is as follows: master valve on filters, oil burners in gas plant, sodium aluminate feeder, aerator pump, agitator and gas compressor, and finally the supply of high-pressure water used by the gas scrubber, the two feeders and the compressor. Should the aerator pump stop or the filter level drop 6 in. for any cause, automatic equipment shuts down the plant.

In starting the filters in the morning, an electric clock is plugged into the oil-burner circuit; when the plant finishes its daily run, the clock circuit is opened, and the next time the operator comes around he finds the clock stopped and showing the true time that the plant has delivered treated water.

In the morning it requires about 20 min. of the operator's time to put the plant into service for the day. Throughout the day he makes frequent inspections to see that everything is operating properly, to keep the lime feeder filled and to make the few daily chemical analyses of water for records. By means of scales supporting the lime feeder, he can check on the weight of lime fed.

Laboratory

As it was unnecessary to build a separate room for the laboratory, a wooden cabinet 4 ft. high by 3 ft. wide and 1 ft. deep was built and mounted in the center of the room over the mixing chamber. In this cabinet is kept the equipment necessary for chemical control of the plant. The cabinet is kept locked when not in use.

A home-made electrically operated dryer has been installed in the lime-feeder hopper and keeps the lime in practically uniform condition, eliminating much trouble in adjusting the rate of feed.

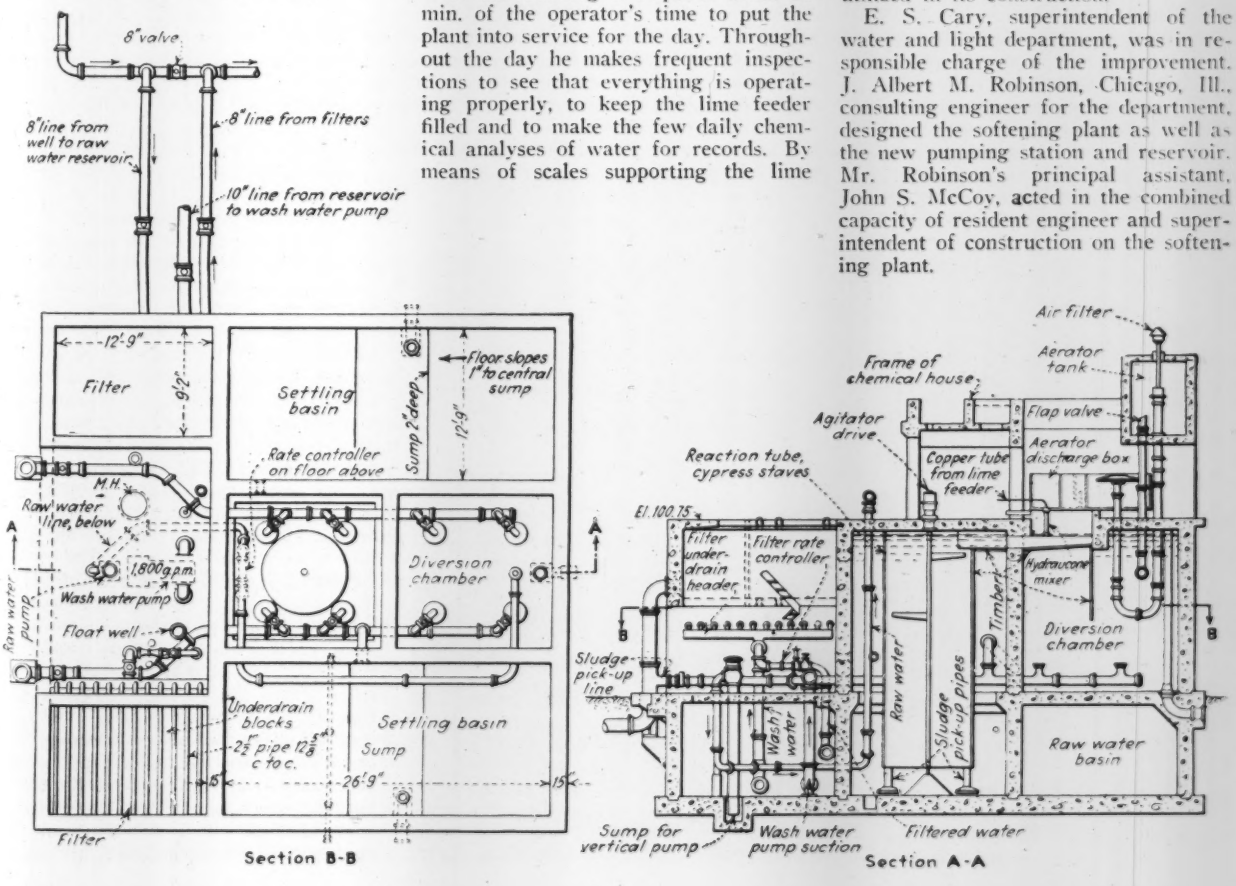
Chemical results

The hardness of the well water is practically constant at 165 p.p.m. of calcium bicarbonate and 150 p.p.m. of magnesium bicarbonate, with no sulphate. In the treatment 4 lb. of hydrate of lime with a maximum of 0.15 lb. of sodium aluminate per 1,000 gal. of water are used. The average total hardness of the effluent is 55 p.p.m. For carbonation about 3 lb. of distillate is burned per hour.

The cost of the completed softening plant was $25,000, of which half was for the structure. Something over 13,000 man-hours of labor were utilized in its construction.

E. S. Cary, superintendent of the water and light department, was in responsible charge of the improvement. J. Albert M. Robinson, Chicago, Ill., consulting engineer for the department, designed the softening plant as well as the new pumping station and reservoir. Mr. Robinson's principal assistant, John S. McCoy, acted in the combined capacity of resident engineer and superintendent of construction on the softening plant.

Fig. 2—PLAN AND CROSS-SECTION, showing mixing chamber, diversion chamber, settling basins and filters.



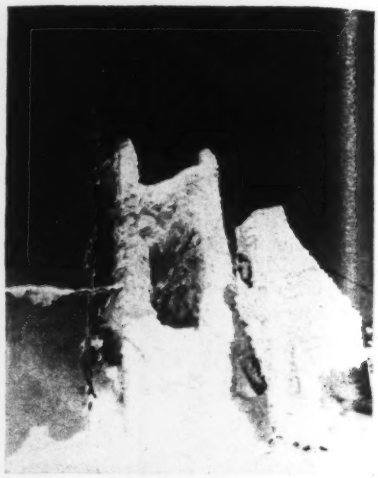
Wind of 231-Mile Velocity Recorded in New Hampshire

Observatory on Mt. Washington uses new rugged anemometer designed to withstand super-hurricane velocities

WHEN newspapers several weeks ago carried accounts of a new high for recorded wind velocities and gave the figure as 231 miles an hour, there were many who doubted that the reports could be true. Anemometers have previously had a habit of blowing away when velocities approached about a 150-mile-per-hour speed. And the velocity reported on Mt. Washington in New Hampshire by the meteorological observatory of Harvard University situated there was nearly 50 per cent in excess of any previous record. However, an inquiry addressed to Charles F. Brooks, professor of meteorology at Harvard and director of the Blue Hill, Mass., observatory, brings the following detailed and instructive reply, which verifies the 231-mile velocity.

"The report of 231 m.p.h. extreme true velocity of wind on Mt. Washington, April 12, 1934, is correct, probably to within 10 m.p.h. The previous maximum observed there was 164 m.p.h. on April 5, 1933. The new high record was made with a rugged anemometer of improved design. The rotor is a copper dish 6 in. in diameter and 2 in. high inverted over an electric stove. From the outer edge of the copper dish six small half-cups, more like ears, extend 1⅛ in. These ears are hollow, to permit a circulation of hot air in them so as to facilitate keeping their tips at temperatures above freezing during the occurrence of rime-forming fogs.

"The anemometer was designed especially to withstand super-hurricane velocities. The essentials of the design were copied roughly from an experimental instrument which I saw in the hands of Dr. Sverre Pettersson of the Norwegian Weather Service at Bergen, Norway, in 1931. Several of us, including David W. Mann, improved on this to meet the extreme conditions of Mt. Washington, and the anemometer which recorded the high wind was made by the Mann Instrument Co. for us early in 1933. It was tested in one of the M.I.T. wind tunnels and put into service. Later, in November, 1933, after further improvemnts in design, it was tested up to 150 m.p.h. in the wind tunnel at the Bureau of Standards. The calibration curve at this speed had become nearly a straight line, which seems to make reasonable an extrapolation to higher velocities. It was on the basis of such an extrapolation that the 308-m.p.h. *indicated velocity* on April 12 was reduced to the 231-m.p.h. *true velocity* reported.

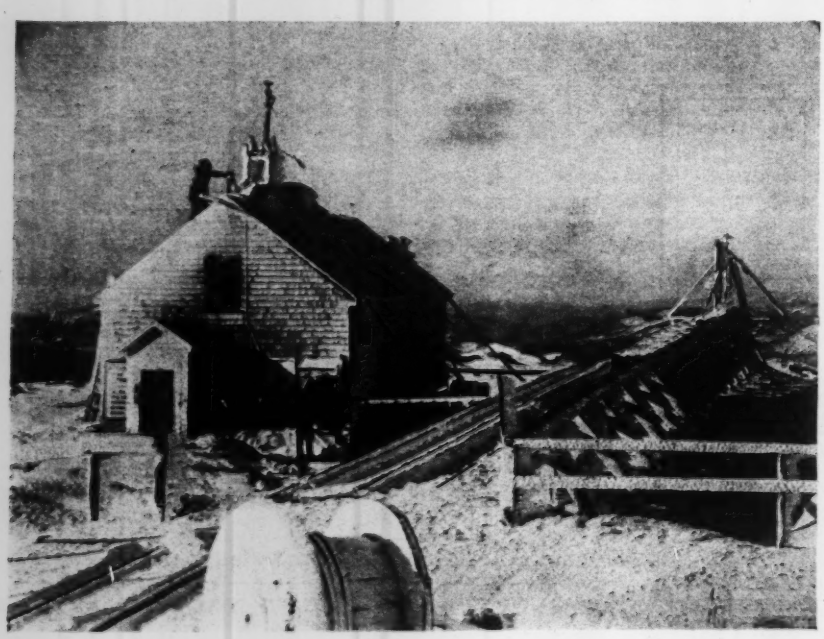


ANEMOMETER consisting of a copper disk equipped with six half-cups and enclosing an electric heater on top of the Mt. Washington observatory. The snow-like deposit is rime (frozen fog) which sometimes grows out 5 or 6 ft. into the wind.

"Two men timed the wind on Mt. Washington, and I timed it (by radio) at Blue Hill shortly before the maximum, getting 216 m.p.h. for the fastest 0.4 miles. The 231-m.p.h. velocity was for the fastest 0.1 mile, as represented by three 1/30-mile contacts timed by stopwatch. The maximum mile was about 225 m.p.h., the fastest for 5 min. was 188 m.p.h., the fastest for a whole hour was 173 m.p.h., and the average velocity for the fastest 24 hr. was 120 m.p.h., April 11-12. All these figures appear to represent the highest velocity of natural wind ever measured.

"These velocities do not represent the highest wind that has occurred, and it has been possible to infer from wind effects that velocities exceeding 250 m.p.h., even up to 500 m.p.h., occur in tornadoes. In the opinion of the observers on Mt. Washington, this 231-m.p.h. velocity did not represent unprecedented conditions. Salvatore Pagliuca, chief observer there, believes that other winds equally strong have occurred in the two winters he has been there, but that, owing to mechanical difficulties, it has not been possible heretofore to measure them. The record velocity was obtained at a height of 10 ft. above the top of the observatory building at the top of the steep southeast slope of the mountain, up which the wind came. In the free air it is doubtful whether the velocity exceeded half that on the mountain. The 140-m.p.h. true velocity, the record obtained during the seventeen years of Signal Corps occupancy, was during a terrific storm, but the anemometer was very poorly exposed (held out a window) and undoubtedly did not catch the full impact.

OBSERVATORY BUILDING on Mt. Washington on top of which is the heated anemometer that measured a 231-m.p.h. wind on April 12. Another heated anemometer and a heated wind vane are mounted on the end of the trestle.



"The velocities at the Mt. Washington station are recorded on a Friez triple register, but the extremes were timed by stopwatch as well. The period of record begins in November, 1932, with the first heated anemometer, which is still in use. The stronger design of heated anemometer has been the standard since May, 1933. The record of wind is fairly complete from November, 1932, but it has not been possible always to prevent the formation of ice on the rotor in freezing fog, even with 700 watts applied continuously in the electric heater inside it. Thus, in the strongest and coldest winds, the record has been intermittent, though correct for 5-min. periods once an hour, after the observers cleared the ice off. The April 11-12 storm had a temperature from 15 to 22 deg. F., which was not low enough to make ice form on the heated anemometer. About 3 ft. of rime formed on unheated exposed objects during the storm and undoubtedly contributed rigidity which protected the summit structures against damage.

"It is pertinent to emphasize the fact that the density of the air on Mt. Washington is only about three-quarters that at sea-level, so that the impact of the 231-mile wind must be discounted to the equivalent of about a 180-mile wind at sea level. Furthermore, when comparing this with hurricane wind pressures, the weight of the flying rain and sea spray on a coast must be placed to the credit of the hurricane's wind pressure. In my opinion, the wind force in the worst West Indian hurricanes equals or exceeds that measured recently on Mt. Washington.

"Mr. Pagliuca presented a detailed paper on this extraordinary wind measurement at the meeting of the American Meteorological Society at Washington, D. C., April 25. It was discussed at some length by Weather Bureau officials, but the accuracy of the measurement and reduction to true velocity by means of the extrapolated calibration curve were not questioned. It is probable that the paper will be published in the *Monthly Weather Review*."

Plans Announced for Purchase of Submarginal Lands

PRINCIPLES governing the selection and purchase of submarginal lands to be taken out of cultivation and turned to other uses have been announced by the Federal Surplus Relief Corporation, through Harry L. Hopkins, president. The present funds of the corporation, $25,000,000, will suffice for acquiring only a small part of the now cultivated lands that are known to be below the level of profitable agriculture and that should be taken out of cultivation, but it is believed that a score or more of large tracts can be acquired in different parts of the country and that an effective demonstration of the practicability of submarginal land retirement can be made through this fund. The present program, accordingly, is frankly recognized as a test or demonstration program, having in view the development of a rational federal and state plan policy for land in problem areas.

Five principles have been established to guide in the selection of lands to be acquired:

1. That the project includes land now used for agricultural purposes which normally does not yield sufficient income to support its occupants.
2. That the land is suitable for other beneficial public use, such as forestation, grazing, park or recreation service, and the like.
3. That the occupants of the land will cooperate in resettlement.
4. That adequate plans for resettlement are developed.
5. That an existing public agency, local, state or federal, or a joint agency of two or more of these, will assume responsibility for the project by definite agreement.

The total submarginal land problem is believed to affect millions of acres in the United States, in all a substantial fraction of the total area now in agricultural production. The principal type areas are the dry farming lands of the northern part of the great plains, cut-over timber lands in the northern states, exhausted cotton and corn lands of the southern Piedmont, and the rough areas subject to soil erosion that border the major rivers. These lands are believed capable of development for grazing, recreational use (parks and camping areas), game and bird refuges, forestation and the like. In a number of the western states submarginal areas adjacent to Indian reservations are planned to be incorporated in the reservations with a view to bettering the now deficient opportunities of the reservation tribes.

One of the demonstrations, which will probably be devoted to grazing, is planned for the area directly north of the Ohio River and may be located in southern Illinois. The result of this experiment is thought to be applicable to the entire southern strip of Ohio, Indiana and Illinois, which has similar topographic and soil conditions. An opportunity of quite different kind exists in northern Wisconsin, where the acquisition of some 150,000 acres of cut-over land for forestation and recreational uses will permit of the readjustment of some 4,000,000 acres. In Georgia a large tract, possibly exceeding 100,000 acres, adjacent to a subsistence homestead project now going forward, may be developed in forests as an adjunct to the project in question, as it would provide working opportunity for a considerable fraction of the project's population.

Plans of more or less definite character have been developed for projects in 25 different localities. All the project planning is being developed in close cooperation with existing federal and state agencies.

Rubber Paving Blocks in Mersey Tunnel

RUBBER PAVING BLOCKS have been installed in a short section of the vehicle tunnel under the Mersey river between Liverpool and Birkenhead in England, in addition to the line of amber-colored rubber paving blocks used to indicate the traffic lanes in the tunnel, as noted in the description of the Mersey River tunnel published in *Engineering News-Record*, Nov. 16, 1933, p. 581. In response to an inquiry from this journal as to the amount of rubber paving in the tunnel, Brian H. Colquhoun, resident engineer, states that 2,000 of the 50,000 sq.yd. of paving in the tunnel is of rubber. The remainder is of cast-iron blocks, as shown in the view of the tunnel in the news pages this week.

In Birkenhead the tunnel passes over the Mersey Railway tunnel, and it had always been agreed by the engineer that, provided a suitable resilient roadway surface existed at the time, he would lay such a surface in the part of the tunnel where it crosses the railway tunnel. At about the time the engineer was considering the road surface, the Universal Rubber Pavors, Ltd., designed a rubber roadway in which the block was only 2 in. thick. It was therefore decided that about 2,000 sq.yd. of this type of rubber roadway should be laid in that part of the tunnel where it crosses the railway tunnel. The same firm has supplied the amber-colored blocks for the traffic markers.

Channel Regulation by Dikes on the Middle Mississippi

Project for 9-ft. navigation from St. Louis to Cairo nearing completion—Legislative history, planning principles and contraction structures outlined — Results effected

By B. M. Harloe
Captain, Corps of Engineers, District Engineer, St. Louis, Mo.

FOR navigation improvement the Mississippi River divides according to characteristics into three somewhat sharply defined sections. These are: the Upper Mississippi, from the mouth of the Missouri River (St. Louis, Mo.) to St. Paul, Minn., about 646 miles; the Middle Mississippi, from the mouth of the Missouri River to the mouth of the Ohio River (Cairo, Ill.), about 195 miles; and the Lower Mississippi, from Cairo south about 1,070 miles to the head of the passes into the Gulf of Mexico. As affecting the maintenance of navigable channels, each of these sections presents broadly a different problem, and the solutions adopted differ in general, although for the middle and lower river certain procedures are the same.

Above the mouth of the Missouri the Mississippi is shallow, fairly clear at low stages, full of islands and has fairly stable banks and bed. Here the river is being improved (*ENR*, March 8, 1934, p. 322) to provide a 9-ft. channel by means of locks and dams. Its main tributary, the Illinois River, has been similarly improved. Below the mouth of the Missouri the characteristics of that stream predominate; steeper slopes, caving banks, shifting bed and turbid waters carrying large quantities of silt in suspension. For the middle Mississippi to Cairo open river methods of improvement are being employed. In the lower river south of Cairo the characteristics of the middle river are accentuated, and added to them is the dominating problem of flood control. Here the combined problem is being attacked by regulating works, levees, shortening, slope improvement and floodways as reviewed in *Engineering News-Record*, June 22 and 29, July 6, 13, 20, 27, and Aug. 3, 10, 1933. Incidentally the Ohio River, which enters the Mississippi at Cairo, is improved by locks and dams.

Project history

Fig. 2 is a location map indicating the sections of river, the tributaries described, the character of the navigation works and particularly the St. Louis district under whose engineers the Middle Mississippi improvement is being carried out. The legislative history of the present project began with the adoption of a plan for regulating works in 1881. Dredging was introduced as a part of the project in 1896. The River and Harbor Acts of 1905 and 1907 and the joint resolution of June 29, 1906, practically abrogated that part of the project which proposed regulating works. An act of 1910 restored regulating works to the project and began appropriations with a view to completing the works in twelve years at an estimated cost of $21,000,000. The River and Harbor Act of 1927 provided for a 300-ft. channel, 9 ft. deep, which is the project now being carried out. The total cost of the work exclusive of maintenance to June 30, 1933, was $27,000,000. At that date the regulating works were about 77 per cent completed. The extent of the improvement to be made by the Corps of Engineers has of course been dictated by the acts of Congress and by the appropriations made available from time to time.

The middle river has, however, a still earlier improvement history than the present project. In 1820 Congress authorized a reconnaissance survey which resulted in a very good sketch of the river made by Captains Young and Poissin, topographical engineers, and Lieutenant Tuttle, Corps of Engineers. In 1824, $75,000 was appropriated for snagging, which has been continued since except for brief intervals during the Mexican and Civil wars. The first permanent improvement was the erection of a pier (short solid dike or wing dam) on Bloody Island (now part of East St. Louis, Ill.), to give direction to the current at St. Louis. This structure was built in 1838 and 1839 by Captain Robert E. Lee, Corps of Engineers.

Since these early beginnings the project has, as stated, gradually been enlarged and modified to meet the increasing demands of commercial navigation. At present the mission assigned is the project approved by Congress in 1927, which requires a 9-ft. minimum depth and a 300-ft. minimum width of channel. These dimensions are considered adequate for the large tows now using the river. A typical tow of the Federal Barge Line consists of a towboat and six barges arranged three abreast. Each barge is 45x230 ft., with a carrying capacity of 1,200 tons when drawing 6 ft., or a total for the tow of 7,200 tons. The over-all dimensions of the tow (towboat and barges) are about 135x690 ft.

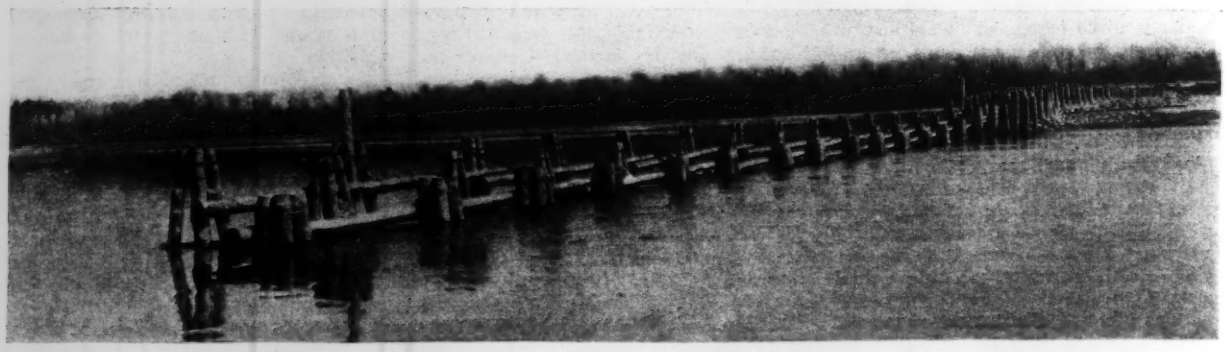


FIG. 1—DIKE at Giboney Island, typical of permeable pile dikes constructed for channel regulation on the Middle Mississippi River. This dike has three rows of pile clumps, but may have fewer or more.

Middle river characteristics

Visualizing the river before improvement was undertaken, the following characteristics are indicated. In general, the valley from below St. Louis to Commerce, Mo., was about 4 to 5 miles wide from bluff to bluff, the stream flowing in an alluvial bed of its own deposit. Evidence existed in the form of horseshoe lakes near the main stream and in deteriorating old chutes that during the course of the centuries

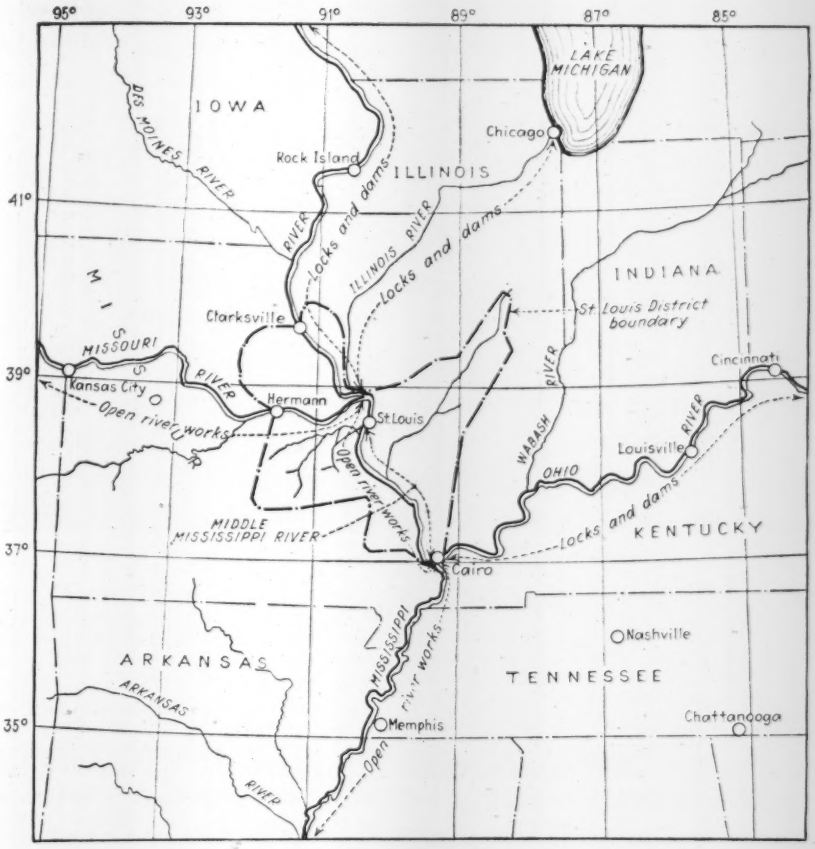


FIG. 2.—LOCALITY MAP of Middle Mississippi, showing types of navigation works on main river and its tributaries.

the river had wandered from bluff to bluff, the change in course being gradually effected by the caving of banks, deposits of material and cutoffs across narrow necks of land in time of flood and high water. Between low water and bankful stages the stream itself varied in width from 200 to 2,400 yd. Where the river was widest, a number of islands, chutes and secondary channels were found. As in the case of most alluvial streams, others of its characteristics may be summarized as follows:

1. Bends and intervening connecting reaches.

2. Deeps (usually found in the bends) and intercepting shoals at the crossings where the thalweg crosses from the concave side of one bend to the opposite side of the river in the reach or bend of opposite curvature below (Fig. 3). The natural minimum depth for navigation on the bars or crossings was 3½ to 4 ft.

3. Comparatively flat-surface slopes in the pools connected by steeper slopes over the bars or crossings, with consequent slow and fast currents in alternation. Shoals that rose and fell with river stages.

4. An ever-moving bed load as witnessed by the formation of bars, which build up in the crossings during high water and are later cut down by the low-water flow, all bars of alluvium constantly moving downstream mainly by transference of material from their upstream to their downstream faces.

5. A tendency of the low-water channel to wander from side to side forming a crooked channel, and the subsequent tendency of high-water flow to straighten and to destroy the low-water channel.

Many other facts concerning this stretch of the river have been disclosed by the frequent surveys, gagings and studies of the stream that have been made over a period of a century. From the Ohio to the Missouri the Mississippi has a slope of about 0.6 ft. per mile, a minimum observed flow of 24,000 cu.ft. per second and a maximum estimated discharge of 1,300,000 cu.ft. per second (high water of 1844). The mean flow of the stream is about 185,000 cu.ft. per second, of which about 100,000 cu.ft. is supplied by the Upper Mississippi and the remainder by the Missouri. The range in stage at St. Louis is 46 ft. and at Cairo 57 ft. The silt carried as bed-load and in suspension is contributed principally by the Missouri. Studies of silt content have resulted in an estimate of 170,000 acre-ft. as the amount of silt brought into the Mississippi by the Missouri annually. The river is closed to navigation by ice an average of 37 days a year, the average date of closure being Dec. 25.

Regulation of the middle river under

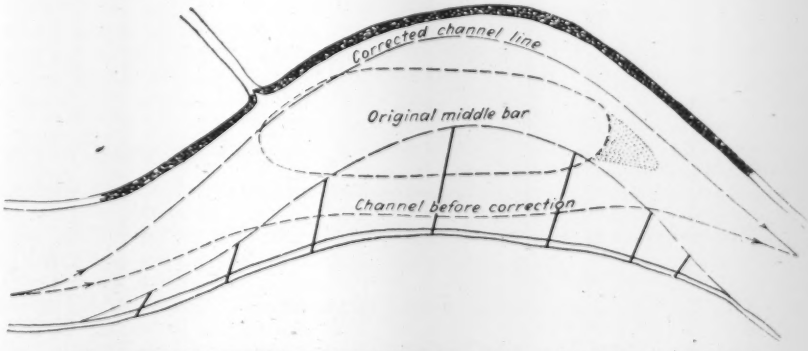
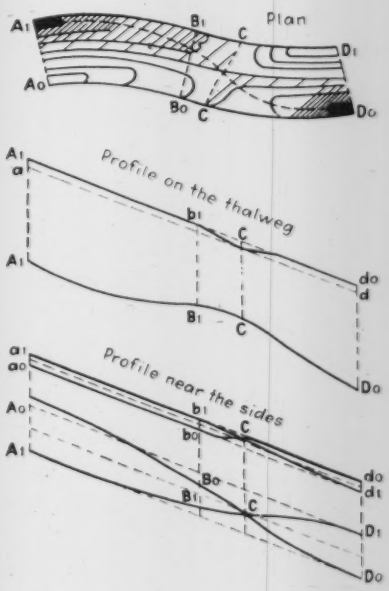


FIG. 3—TYPICAL DIKE ARRANGEMENT, showing protection of opposite bank by revetment together with channel location before and after correction.

FIG. 4—TYPICAL BEND, showing trace of thalweg and profiles on the thalweg and the sides.



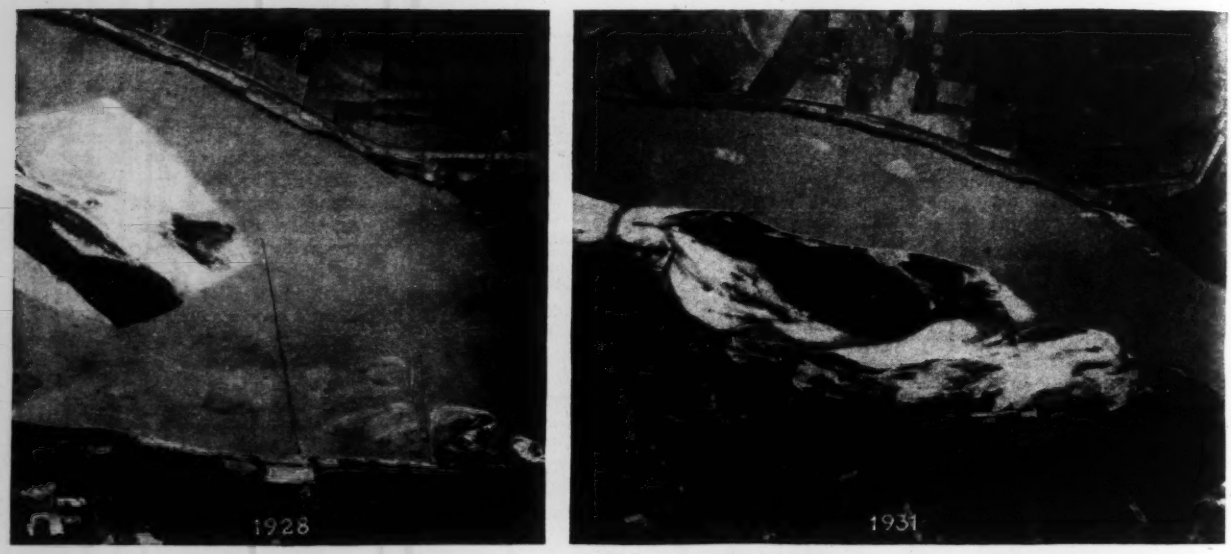


FIG. 5—CHANNEL CONTRACTION resulting from dike construction at Rockwood, Ill. Condition immediately after completion in October, 1928, is shown at left, and condition 3½ years later is shown at right.

the project plan has the broad objective of maintaining the 9 ft. deep, 300 ft. wide navigation channel named by law, by contraction works which concentrate the low-water flow. In general, the basic objectives sought are as follows:

1. To confine the low-water flow to a single fixed channel of suitable width.

2. To fix the trace in a succession of bends, the radii of which as nearly as possible duplicate those found in nature in the best stretches of river.

3. To direct the flow of the water at the crossings so as to assist the low-water flow in cutting a channel through the bars that connect the deep-water pools.

The accomplishment of the first purpose involves the closing, by suitable structures, of chutes and secondary channels that rob the main stream of the water so badly needed during the low-water flow in the fall of the year, and the narrowing of this flow to a width (2,250 ft.) which will assist in maintaining the 9-ft. depth required in the channel.

An alignment of easy curves rather than straight reaches is sought in order to secure the good depths which the river naturally tends to maintain on the concave side of bends. In straight reaches the low-water channel has a great tendency to wander, thus resulting in a more crooked trace and frequently in a split channel due to the formation of troublesome middle bars. There being no fixed tendency in a reach for the thalweg to follow either shore, the channel alignment is the result of haphazard interaction of the force of entrainment of the flowing water and the varying resistances of the materials composing the bed, the water breaking through in those areas where the lighter and smaller material offers least resistance to erosion.

An alignment in bends has the further advantage of fixing the bars at predetermined localities, i.e., on the crossings connecting the pools in the bends. This assists materially in accomplishing the third purpose, which is to direct the flow at the crossings so as to assist the low-water flow in maintaining a navigable depth in a reasonably straight direction over the bar.

It is to be noted that the complete elimination of the bars at the crossings is not sought. We can only hope to get a river of this size to deposit the tremendous quantities of material carried during high water at predetermined localities and as far as possible in a predetermined manner. The effort is to guide Old Man River in his good tendencies and to eliminate the very bad ones. The entire removal of the bars is not to be desired even if such a procedure were possible. The bars themselves are submerged dams provided by nature, which retard the rate of runoff in the critical low-water period. As in the case of artificial dams, we must not open them too much and thus drain the pools above.

Flow formulas merely indicative

The standard formulas for flow in open channels, $Q = Av$ and $v = c\sqrt{rs}$, also Bazin's and Kutter's formulas for determining the coefficient, are useful as guides in determining the best theoretical width for the low-water flow and to study the cause or effect of local changes in slope, depth and area. Another very useful formula for the flow of water in open channels, $v = R\sqrt{\frac{1{,}000\,i}{R/12 + 0.356}}$, has been deduced by William Penniman, senior engineer in the St. Louis district office.

However, it is believed that it can be fairly stated that hydraulic theory has not as yet advanced to the point where the practical problems arising in connection with the "open river" improvement of an alluvial stream may be solved mathematically because of the many variables involved. Design may be made for a low-water flow of 50,000 sec.-ft., but the discharge is fluctuating constantly and may be as low as 24,000 sec.-ft., or a flood of 1,300,000 sec.-ft. The cross-sectional areas at any two sections are not exactly alike in either size or shape. The composition of the bed is variable, and the quantity of material delivered by the tributaries is a function of the variable flow in those tributaries. Answers to the practical questions of alignment, width, depths and velocities must be sought in the river itself both in its natural reaches and in its improved sections.

Further excellent guidance is of late being found in the results of model tests at the U. S. Waterways Experiment Station operated by the Corps of Engineers at Vicksburg, Miss. Here the technique of constructing and operating models of rivers of alluvial bed is being most satisfactorily worked out. Proposed dike and revetment layouts at two localities in the St. Louis district were tested by models at this laboratory, and the results indicated as obtainable from the model studies have been closely duplicated by the works as laid out in the river.

Permeable dikes

The principal tools in this work are revetments and permeable dikes of piling, Fig. 1. The purpose of the revetment is to prevent the erosion of the river banks. It consists of two parts, the underwater protection being supplied by a willow or lumber (1x4-in.) mattress woven continuously in a downstream direction and of varying width

depending upon the depth of water and velocity of current. Continuous cribs or pockets, 4 to 8 ft. square and from 12 to 20 in. deep, are built around the edges of the mattress, later to be filled with stone when sinking the mattress to the bed of the river. The landward edge of the mattress is temporarily anchored to trees or deadmen along the top of the bank. The bank above the water line is graded to a slope of about 1 on 2½, generally by hydraulic jets. The slope is then paved with stone. On very sandy banks a layer of crushed rock is placed under this stone paving.

The primary function of the permeable dike (sometimes called hurdle or fence) is to lessen the velocity of the silt-bearing water, thereby causing a deposit of alluvium. In the course of several years of high water this deposit builds up, willows start growing, causing more rapid deposit in subsequent high waters, and eventually in about eight or ten years a new bank line 15 to 20 ft. above low water is formed along the line of the outer ends of the dikes, and the desired low-water width of the river is attained. This new bank line may then be revetted if required. A crib dike may be substituted in those few localities where rock outcrops and piles cannot be driven. The cribs are filled with alternate layers of brush and stone.

The pile dikes are built of varying numbers of rows of clumps, the number of rows depending upon the depth, current velocity and similar factors affecting the severity of the attack which the dike will have to withstand before it is silted in. Before the piles are driven, a lumber mattress 100 to 200 ft. wide is built and sunk along the line of the dike to prevent bed erosion at the dike line. A typical series of dikes along one shore (Fig. 3) will consist of a short upstream dike built in a markedly downstream direction and designed to deflect the flow away from the bank. The remaining dikes of the system are sloped very slightly downstream, but are in general perpendicular to the direction of the current. To prevent high-water scour around the landward end of each dike, the bank is protected by paving and a shore mattress.

That these dikes have proved very successful in obtaining fills is attested by Fig. 5, showing a dike about 4,000 ft. long located at Rockwood, Ill. The first photograph was taken in 1928, the year of its completion, and the second picture was taken 3½ years later. A second example is Ste. Genevieve Bend, shown in Fig. 6.

A necessary adjunct to this system of improvement is dredging during long periods of very low flow. A particularly trying time is after a rapid fall in stage from a previous prolonged medium stage. The bars at the crossings have built up during the medium stage, and the flow at the lower stage has not as yet cut its low-water channel through these bars. For this type of work the principal reliance is on the Mississippi River type (or dustpan) hydraulic dredge. As its name indicates, this dredge is equipped with a dustpan-shaped suction head equipped with a series of hydraulic jets. The material to be dredged is jetted loose, drawn through the suction head, through the pump and discharged through a floating pipe line usually about 500 to 750 ft. long. The two largest dustpan dredges in the St. Louis district are the Fort Chartres and the Fort Gage, which have a 32-in. discharge. They average about 2,000 cu.yd. per pumping hour. They were built in 1908. More modern dredges of this type, built for the United States District Engineer in Kansas City in 1931, have a 34-in. discharge and can average about 4,000 cu.yd. per pumping hour in material of the kind found in the stretch of river under discussion.

The more liberal appropriations in recent years for the improvement of the

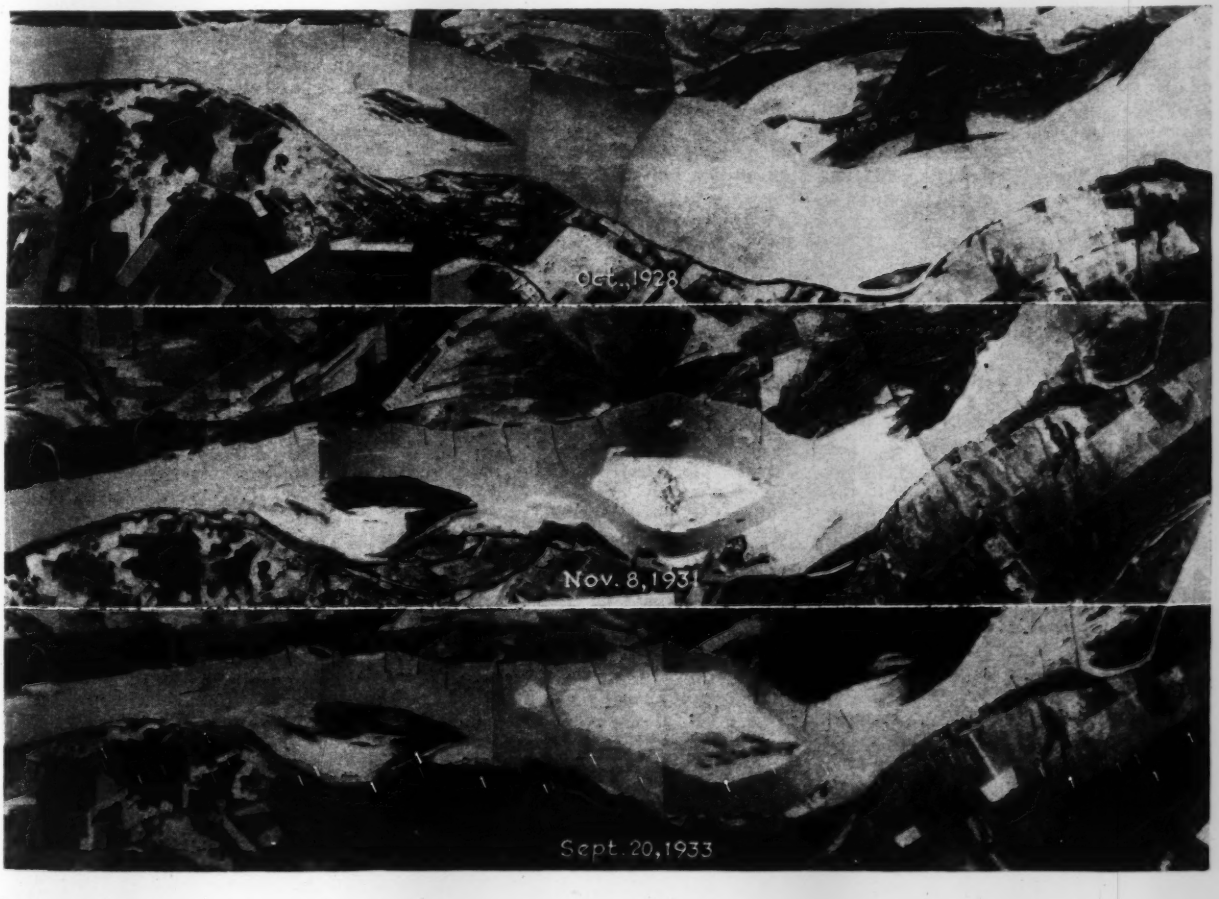


FIG. 6—STE. GENEVIEVE BEND, showing improvement in channel alignment from construction of system of dikes.

Mississippi River between the Ohio and the Missouri have made possible the orderly prosecution of a comprehensive plan. With the type of improvement described above, this is essential. To install this class of work, with particular reference to pile dikes, at isolated localities, is to invite trouble. This is true because whenever these regulating works are installed in one locality the regimen of the river is changed not only at that particular place but also above and below. These latter changes may be detrimental ones. Also, after the works are installed and before they become effective (which in the case of dikes is not until several high waters have passed over them), the river regimen is upset and in a state of change. This is usually bad for navigation. Also, if the river is not stabilized above and below the locality in which the work is being undertaken, it may start at some other point and change its course entirely, either abandoning the works that are being built or destroying them.

The benefits that have been secured by the work installed in recent years is illustrated by the fact that while the last three years have been ones of unusually low flows in the navigation season, it has been possible, by supplementing the regulating works with a rather extensive dredging program, to maintain navigation by the large tows designed for a channel of project dimensions. This could not have been done with similar stages prevailing prior to the installation of the present works.

Capital Goods and Construction Before Chamber of Commerce

United States Chamber of Commerce sessions in Washington last week provided some constructive suggestions for the engineering constructor and capital-goods manufacturer

TWO SESSIONS of the U. S. Chamber of Commerce in Washington, D. C. during the past week devoted to consideration of construction progress and the recovery of capital-goods production as affected by the National Industrial Recovery Act brought out comment and criticism of major interest to engineers and constructors. Brief summaries and excerpts only are possible of discussions having the most direct bearing on civil engineering and the contracting business. All are the conclusions of men who have earned the right in their particular fields of business activity to speak with knowledge of its condition and requirements.

Limiting PWA regulations

Commenting on the problems of recovery of construction, N. F. Helmers, president, Associated General Contractors, commended efforts by the federal administration to promote public works. He said, however: "There have been regulations thrown about the spending of construction money which are unsound. I refer particularly to the 30-hour-week limitation on PWA projects. I believe this should be increased. It has an altogether disproportionate effect on indirect and overhead costs. The construction industry has in effect, under the auspices of the National Recovery Administration, a code of fair competition, which provides a somewhat longer work week.

"These figures were arrived at by a long series of meetings and many studies by scores of members of the construction industry, in collaboration with the National Recovery Administration, over a period of eight months. The figures are regarded by the industry as economically sound, and the industry's attitude is that from the standpoint of the public, it is better to obtain the services of a man for a reasonable work-week for a stipulated wage than to require only 30 hours' work from him and pay him the same weekly wage. We believe that on this basis the public will get a better value per dollar spent for construction, and the workers in the construction industry will be as well satisfied and as well off in their living standards. At the same time, if the public is to spend two billion, five billion or ten billion dollars for construction, it will get more permanent useful construction with a longer work-week, and as many people will be employed.

"The code of fair competition for the construction industry also provides a minimum hourly wage of 40c. and contemplates that all normally higher wages for both skilled and unskilled workers will be adjusted by the industry through mutual agreements with employees. Under the Public Works Administration's regulations, however, there is a definite minimum stipulation for unskilled labor, and one for skilled. In the southern region, this is 40c. and $1. In the middle section of the United States this is fixed at 45c. and $1.10. In the northern belt the schedule is 50c. and $1.20 per hour. In borrowing from PWA to construct public works, the political subdivisons of the United States must borrow on this basis, and some day they must repay on this basis. In a great many cases these political subdivisions have not heretofore found it necessary to have their public works constructed at such a high wage scale. This serves to unbalance the tax structures and commercial and industrial situations in those communities.

"On construction work financed by PWA money, it is now required that to the fullest extent possible labor shall be chosen from lists of qualified workers submitted by local employment agencies designated by the United States Employment Service. I do not question the motive in this regulation. It was intended to give everybody a chance to work. It does not, however, result in economic construction costs. A great proportion of the men submitted to the contractor, which he must employ at least temporarily, are unfit for his work. He must cull them over and gradually dispense with the unfit and replace them by more competent men during the course of the work. This greatly increases the cost of his "labor turnover," slows up the work to a considerable extent, and breeds, in many cases, a high degree of inefficiency in construction operations.

"The necessity for selecting inexperienced and unqualified men from unemployment lists also results in increasing the accident hazards on construction work. Despite the fact that PWA regulations require that the Accident Prevention Manual of the Associated General Contractors of America be used on each construction job, there is an increase in accidents. This can be attributed to the fact that the contractor must employ men that he would not otherwise select.

"It is believed that if expenditures of public funds for construction are to be continued, PWA regulations should be modified to an extent necessary to make them comparable with the code of fair competition for the construction industry, which has a legal status as an approved code, and that a curb be placed on the orders and instructions of subordinate PWA officials, which instructions are in many cases impractical and in conflict with the real intent of PWA regulations."

Additional public works funds

An engineering analysis of the public-works program by Harrison P. Eddy, president, American Society of Civil

Engineers, indicated that severe unemployment conditions were certain to continue without further federal provisions for public works. He stated:

"The public-works program in itself is not a cure-all for depressed business conditions and unemployment. There is little doubt, however, that by the summer of 1934 it will have proved itself of material assistance to business activity and re-employment. It is not unreasonable to expect that by mid-summer 4,500,000 persons who were unemployed in March of last year will have jobs. Of this number, perhaps 2,500,000 to 3,000,000 will owe their jobs, either directly or indirectly, to the public-works program.

"It is estimated that approximately 4,700 non-federal projects now are pending in the Public Works Administration in Washington, for which no funds are available. The total estimated monetary value of these projects is $3,000,000,000. It is anticipated that projects to the value of at least 50 per cent of this amount would qualify for loans and grants under present requirements of the administration.

"All these considerations seem to indicate the advisability of making another substantial appropriation for public works. If an appropriation of $2,000,000,000 were made, it would take care of non-federal projects aggregating $1,500,000,000 and leave $500,000,000 for federal projects. Useful projects of the latter class would include the construction of highways, the elimination of both railway and highway grade-crossings on main highways, and the Civilian Conservation Corps work. An appropriation of $2,000,000,000, with the present wage scale and hours of labor established by the administration, would furnish direct employment to some 800,000 men for a year. If this fund were administered in such a way that a substantial proportion of construction projects financed from it could be begun next fall, when employment under the present appropriation begins to decrease, the peak employment on public works anticipated for the coming summer could be maintained for a full year. Such a program would furnish a year's employment, both direct and indirect, for 2,500,000 to 3,000,000 persons.

"If the Public Works Administration could be decentralized, so that investigations in regard to engineering soundness, financial acceptability and legality of projects could be made finally, or with but limited regard to review in Washington, the procedure would be speeded up.

Of course, the natural objection to decentralization is that it makes control by the central authority difficult, and for this reason complete decentralization is inadvisable.

"Considerable help would result from a more flexible administration of the labor restrictions of the present act. They are particularly irksome in the rural districts and small towns and cities."

Capital-goods recovery

Reviewing monetary policies, Ralph E. Flanders, president, Jones & Lamson Machine Co., considered that "Both governmental and private policies affect the demand for capital goods in general, and for machinery and equipment in particular. Until recently the governmental factor has been the controlling one. Certain changes in policy and proposed modifications in legislation in the last few weeks indicate that the bars to recovery from this direction are being raised." He stated that in this event, "Private business and private finance will have the major responsibility placed definitely in their hands. The question is, will private enterprise rise to the challenge, or have we suffered too long and too debilitating a dependence on federal bottle-feeding?

"We have two things to do: rid ourselves of fear, and rid ourselves of folly. I have said something about the fear. There is also time for a word or two about the folly.

"We must learn to be content with business profit—with the solid social rewards which come from the exercise of wealth-producing, not wealth-appropriating, activities. It will always prove fatal to make our principal interest the search for illusory and unsocial speculative gains.

"Business must not seek to protect itself unduly but must be willing to undergo the dangers of such a degree of competitive freedom as will insure the continued success of efficient management, and encourage the passing on of the fruits of that efficiency to the consumer, in terms of lower prices.

"One of the social frontiers is the 40-hour week—a new determination of the balance in human values between labor and leisure—a dividend of our improved machinery and management partly earned by past performance, partly owed in faith of future efficiencies not yet attained. That frontier has only been rudely mapped. It has not been occupied and settled. It is going to take better machinery, better methods, better organizations than we have ever had to maintain that frontier position, and at the same time make that advance in the general standard of living which constitutes our other social frontier."

Capital goods helped by NRA

Malcolm Muir, president, McGraw-Hill Publishing Co., speaking emphatically of a promising future for capital good business, said.

"Four years of depression, with the tremendous backlog of unfilled needs which they have created, have done a lot to make investment in capital improvements attractive. NRA and other government agencies, through the stimulus they have given to purchasing power, have also done a lot. Industry, once it gets well under way again, is in a position to go into years of its greatest productivity and profit-making, and should be able to make a good return on investments in it. Much of this is attributable to NRA, which, in spite of increasing costs, has, through its fair-trade-practice stipulations, established business on a sounder competitve basis than it has had for generations. Whether NRA continues as a part of our industrial structure or not, I think that its principle should remain as essential requirements for a flow of private investment to be maintained, and that they will be used by the investing public as a yardstick of sane and fair practice in the conduct of any enterprise in which the investment of savings is invited.

"There are several bogeys that have to be killed and considerable education work to be done in connection with capital investments today. The first bogey, and the most important one because it is subscribed to by many people in high places whose influence is great, is the one about overproduction—of both consumer goods and capital goods.

"It is important that the overproduction bogey be squelched. If it isn't, it will stand always as a barrier to investment in capital improvements. It ignores the fact that we have a new economic order today, it ignores obsolescence, and it ignores the fact that a high-cost plant under controlled competition will meet a sure death if not a sudden one—and I am more inclined to think they'll come together.

"Another bogey that must go is the idea that profit, *per se*, is wrong. Widely publicized investigation of unfair profits has led to the notion popular in many quarters that all profit is tainted. It is even more important today that business and industry should operate at a profit than it has been for many years past. Profits, for management and labor alike, are what keep the standards of living high and the demand for goods active.

"It is a popular misconception that our markets for various products are saturated. The phenomenal automobile records that are being set this year—one of the best, so far, in the history of the industry—may do something to offset that notion. Perhaps the markets for railroad products have been saturated—but if they have, it is only for types of equipment that have become obsolete. There's a vast new market for lightweight high-speed equipment. The street-car business, or a time thought to be on its last legs, has revived with modern equipment, which means higher speed, greater riding comfort, economy of operation.

"These things weren't pulled out of a hat. Courage, foresight, and a lot of hard selling entered into the proceedings at a lot of points between the ideas and their accomplishment."

ENGINEERING NEWS-RECORD

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High Storm Velocities

MANY of the engineer's beliefs about wind need revising in the light of phenomenal storm velocities observed on Mount Washington, as verified in detail by Prof. Charles F. Brooks' statement on another page. For the first time in meteorological station work, speeds higher than 200 m.p.h. were measured. Though this took place at a mountain-top station, where air-flow conditions are abnormal, data leave no doubt that the conventional limits of thinking in respect to wind exposure of structures will not suffice in future. The partial data on gust ratios contained in the Mount Washington figures strengthen this conclusion, for they confirm what was previously inferred from destructive storm effects as to the marked excess of gust intensities over average wind. As Dr. Brooks properly emphasizes, the impact of spray and wind driven by storm winds must be taken into account in drawing conclusions as to wind pressures that may be developed in other places, where lower maximum velocities are probable. It is especially interesting to learn that storms of equal or greater violence have repeatedly occurred at Mount Washington, judging by the observer's impression. The storm of April 11 was measured only because new instruments ruggedly designed and mounted were at hand. Heretofore anemometers have had the habit of failing when subjected to hurricane or other extreme storm conditions, and this is the chief reason why knowledge of high wind velocities is almost wholly lacking. Now that it has proved possible to build wind gages that can stand up to their service even in storms approaching estimated tornado velocities it is to be expected that such instruments will soon come into general use, and that as a result we will in time obtain more adequate data on very high winds.

A Needed Reconciliation

THE PWA REQUIREMENTS that fix wages and hours and prescribe that labor must be recruited through prescribed agencies are rapidly proving to be the disturbing influence that men familiar with engineering construction feared they would become. Their upsetting effect on production appeared almost at once in roadbuilding, which was the first work to have experience with the new restrictions; road engineers and contractors almost as a unit testified to the inefficiency, damage to equipment and discontent with earnings that resulted from the rules. Now that the lagging PWA operations in other fields are also getting into the active stage, the evidence of discontent is naturally increasing. Further contradiction of policy and practice respecting labor conditions arises from the disagreement between the PWA rules and the provisions of the construction code, which is now effective. The cumulative result is represented in the criticism and comment in this issue by N. F. Helmers in his address last week to the United States Chamber of Commerce. He outlines a situation that calls for wise thinking and quick action if faith and cooperation in code government of construction are to be attained. As Mr. Helmers indicates, the reasonable course is to place PWA work under the code as fast as regional agreements are arrived at. If code government is to develop as a continuing organization of construction, its processes should supersede emergency dictation.

Shall the Campaign Stop?

THE CONVICTION that the public-works program must be continued, at the risk of a dangerous slowing-down of the campaign of business recovery, is quite general among those who have followed the progress of re-employment during the past year. At the meeting of the national Chamber of Commerce last week, Harrison P. Eddy, president of the American Society of Civil Engineers, and N. F. Helmers, president of the associated General Contractors, convincingly expounded the need for an additional public-works fund. A day or two earlier the Construction League had expressed similar views by formal vote. During the week, also, a succession of witnesses from many walks of life, called before the Senate committee on education and labor, was testifying to the importance of an aggressive continuance of the public-works drive. In the background of the situation there looms up the fact that April saw the volume of public relief operations reach the highest figure in history, with nearly five million families on the relief list, and the prospect that next winter will see the relief problem reach even larger dimensions unless in the meantime re-employment is increased by a continued public-works campaign. Despite all these facts the government remains complete inactive, and appears content to let the PWA movement fade away. Must this broadly conceived recovery campaign come to a stop in the face of the conditions that call for its continuance? It is possible that the answer to this question can be shaped by engineers and construction men, if they will carry their convictions to the legislators who represent them at Washington.

The Local Factor

THAT FURTHER aggressive stimulation of the public-works campaign is in order may be judged also from the Michigan vote on April 30, when the electorate turned down by 5 to 1 a proposed $38,000,000 bond issue to support public-works construction financed by the PWA. It is difficult to reconcile this action with Detroit's 2-to-1 vote of last fall in favor of a rapid-transit bond issue more than twice as large. All the local factors of the situation, however, indicate that the latest vote is an expression of the relief complex—the conviction held by many business interests and fostered by social workers that charity is cheaper than employment. Doubtless there are some who felt that the revival of the automobile industry this spring signalized the end of depression conditions; but the fact is that even with automobile production at its peak one quarter of the state's population still is on the relief rolls. The vote suggests that many citizens are willing to transfer responsibility for unemployment relief to the federal government, which is one result of the government's liberality in handing out CWA funds to meet last winter's unemployment. All told, the voters' attitude is largely the outcome of opposition to taxes and faith in charity relief. The proposed bond issue would have increased taxes, and the people of Michigan like those elsewhere are highly tax-conscious. An aggressive

public-works program, however, carried resolutely to the point where the large relief list is cut to a minimum, can overcome this defeatist attitude.

Cut the Red Tape

BECAUSE the working success of the construction code depends on prompt fixing of wages and hours by the area agreements which the code authorized, the first hearing on such an agreement, held last week, was an important event. Hundreds of thousands of such agreements will have to be formulated to fit the many crafts and many regions, but the first hearing makes the prospect of accomplishing this in any reasonable time appear extremely remote. The hearing was convoked at Washington and ended in no decision. Consider what this means to the plumbers of Dallas, for instance. They know that to establish fair competition on an adequate wage basis at this time of a large labor surplus it is essential that a uniform scale of plumbers' wages be made binding on all plumbing contractors in Dallas, or perhaps throughout Texas. They know that the NRA will enforce on all members of the industry a wage agreement reached by representative groups of employers and workers in the area concerned if there has been "due notice and hearing," and if the NRA thereupon approves the agreement. It is not easy to bring together representative groups and agree on wages and hours. But if the parties then must go to Washington for a hearing, spend a day wrangling over the agreement, and finally learn that the matter is postponed to a future hearing, their task becomes quite impossible. The NRA should be able to prescribe forthwith a surer and more expeditious procedure. If not, the code authority and its boards ought to take the problem in hand at once, for they well know that unless early wage and hour stabilization is assured the code may as well be scrapped.

Organizing Construction Interests

IN NATURAL RECOGNITION of the fact that code administration needs a comprehensive industry association to cooperate with it, the Construction League is proceeding to develop itself into a nationwide organization. At its meeting last week it elected eight state bodies as its local representatives. This is the result of a movement toward countrywide organization that began three months ago at the time the construction industry code was approved. By the time the movement nears completion the league will be in a position to serve construction as a whole in the same manner that the national bodies of the craft industries serve their own groups and their divisional code administrations. Questions that demonstrate the need for such service have already arisen in considerable number, because of the new relations between the component elements of construction that have been created by the code; and while some of these questions will be answered by the code authorities and boards, many others are the direct concern of the industry itself. Code government does not take the place of that very essential type of cooperation that is carried out by industrial associations. But construction unfortunately has never had an industry association, for which reason it remained a heterogeneous assemblage of unfriendly and uncooperating groups until the code brought some of its elements together—though unfortunately it left the materials and supply units outside the pale. An active association of all construction interests has work to do far beyond the range of the code, and in fact the improvement of the status of construction depends essentially on its activities. It is therefore greatly to be hoped that the league will proceed with vigor to complete its organization and enter on the broad field of work awaiting it.

Economic Planning Recognized

SOMETHING like the beginning of a new era is marked by the fact that the business and industrial men of the Chamber of Commerce of the United States recognized the importance of public-improvement planning to the extent of devoting to it a special conference session of the Chamber meeting last week. In the past these same men gave no serious attention to such planning. The simple fact is that until the depression showed how closely investment values and business stability are interlinked with broad regional economic factors, the type of study that goes under the names of city planning and regional planning (to which have lately been added national and state planning) had only academic status.

Planning of this type could claim no higher rank, indeed, so long as its characteristic examples were purely esthetic in origin and objective. Business men and government could not be expected to give it serious attention. But business and government as well as the planner have been learning. The planner today studies in terms of utility rather than beauty, and seeks to weigh and measure economic factors, such as land use possibilities in relation to population and industrial growth. Business and government are beginning to understand that such important things as stock and bond values are in part fixed by some of these very factors that they have heretofore ignored; they even suspect that well-thought-out works programs and legislative measures affecting public improvements may influence wages, profits, and ultimately votes.

In short, regional economic study (if we may use this term as a rough equivalent of "planning") has grown to be one of the most important subjects with which the men of industry, commerce and finance have to concern themselves. A few business men—though as yet only a very few—realize this, and the influence of these few was responsible for the planning session of the Chamber. Henceforth, it should be one of the major responsibilities of that body to spread the same understanding through business circles broadly.

The planning engineers have equally essential work to do in making their vocation a more practical science than has yet been developed. They have little more than begun. We have had occasion to see in recent years how the shortcomings of their art may lead to serious consequences. The grave troubles of the public-works program, and still more flagrantly the collapse of the government's ambitious housing program, are largely chargeable to the inadequacy of what has been done in economic planning of city and regional growth. Only now is a foundation being laid for the study of effective residential and housing development, through the factual determination that is begun by the Real Property Inventory. In like manner the present tax difficulties, mortgage distress, school, and public-works problems are matters whose correction awaits thorough economic study. As fast as the planner develops his science and art, therefore, he will help to place our business existence on a more secure footing.

CURRENT NEWS

Chicago Sewage Plan Modified in Report of Review Board

IMPORTANT changes are recommended for the Chicago sewage disposal program, providing a higher degree of treatment at an earlier date, in a report of a special board of engineering review appointed by Administrator Ickes following the $42,000,000 PWA loan and grant made to the Sanitary District of Chicago. The board was composed of: Daniel W. Mead, W. B. Storey, Gen. C. W. Kutz and Joshua D'Esposito, state PWA engineer for Illinois. The proposal to build a 400 m.g.d. activated sludge plant for the southwest side of the city instead of the projected west side supplementary plant constitutes the outstanding recommendation of the board's report. This change is combined with a plan to provide a pumping station and interceptors in the southwest area.

Designs for these developments are figured on quantities of water based on a metered supply which is estimated to effect a cost reduction of $6,000,000 because of the smaller plant capacity required. Use of the activated sludge process was considered in accord with the best modern practice. Chemical processes were not considered applicable as primary methods but might be used to supplement the present Imhoff tank treatment. Sludge disposal would be decided by district engineers, according to the report, and should be predicated on experiments on incineration now under way.

High construction standards have prevailed on works already built but many features were unnecessarily elaborate and extravagant, according to the board. Recent designs have eliminated such criticisms. The report calls for the continued use of Imhoff tanks at the west side plant pending experiments with chemical treatment with or without filtration. Under the proposed plan with activated sludge treatment providing 92 per cent purification for all plants except the Imhoff tanks at the west side, where 33 per cent is obtained, the possible weighted average purification for the district in 1940 will be 72 per cent. If the Imhoff tank effluent can be increased to 70 per cent purification, the weighted average will be 85 per cent which represents a reasonable degree of purification as decided by the special master of the Supreme Court.

The matter of excessive water waste in Chicago was allotted a special chapter in the report which strongly recommended early metering. This will tend to expedite filtration of the Chicago water supply, for metering and filtering must be advanced concurrently to secure the voters' approval.

Requests for the recommended changes to alter the existing program must be made to the Supreme Court and the PWA contract must also be changed. The program suggested by the board is in line with the original plans of the district's engineers.

President Promises Continuance of Federal Housing Program

In a telegram to the National Public Housing Conference, May 8, on the occasion of a dinner given by the Conference in honor of New York City's new Municipal Housing Authority, President Roosevelt stated that the Administration's program of slum clearance and low cost housing would continue to be pushed. Recent reports have contained rumors that the Federal Emergency Housing Corp., which has taken over most of the limited-dividend projects that had received PWA approval, would postpone its activities until next year.

In his message the President said, "The interest of the Administration in low-cost housing is no less than it has been; in other words, it is very great indeed. There is available for such housing, through the Public Works Administration, $125,000,000 for certain demonstration projects—experiments in a way to be carried out this year in various parts of the country.

"We believe that this is about as much as can be used. We feel quite certain that if our first experiments are reasonably successful in showing the way toward the solution of the varied housing problems of different cities that there will be no difficulty in getting the support of Congress for further and more extended efforts along this line."

Flood Control Will Govern Muskingum Project Operation

Flood control requirements will be the governing consideration in the operation of the reservoir system which will be built by the Muskingum Watershed Conservancy District in eastern Ohio. The $32,000,000 program is being constructed under the direction of the U. S. Engineers, financed by a PWA loan.

Following an inspection tour over the proposed reservoir sites in the district, Major J. D. Arthur, Jr., district engineer, U. S. Engineers, Zanesville, stated:

"The project as adopted provides for both flood control and water conservation. In general, it can be said, that where the two are in conflict, as might occur in reservoirs of limited capacity, needs for flood control will govern. In certain reservoirs, it is quite likely that available storage capacity will be sufficient to permit constant impounding of water. In these cases the need for both flood control and water conservation will be met. It is impossible to state as yet the extent to which this practice will be carried, but indications at present are that sufficient water will be impounded throughout the district to provide considerable conservation. This continued storage will tend to increase the ground-water-level throughout the district and should provide a low water flow."

Construction League Elects State Groups—Plans for Extending League Make Progress

EIGHT state Construction Leagues were admitted to the status of local members of the Construction League of the United States at the meeting of the general assembly of the latter body at Washington on April 30. Five of the state organizations, Alabama, Connecticut, California, Indiana and Michigan, had previously been elected by the League's Policy Committee. In ratifying this action the assembly elected three additional applicants, North Carolina, Colorado and Missouri. As a further step in adapting its organization to the increased demands placed upon it by the necessity of serving in full the various construction groups represented in the construction code, the assembly added two sub-contractor members to its policy committee. The men chosen are L. E. Mayer, President of the National Electrical Contractors Association, and C. H. Dabelstein of the International Society of Master Painters and Decorators.

With a view to obtaining proper recognition for construction in legislative and government affairs, the League voted to urge upon Congress the policy of establishing a construction committee in either house. In connection with this decision E. J. Harding, managing director of the Associated General Contractors, emphasized the desirability of having representatives of the construction industry seek election to Congress as well as of committing candidates for Congress, in advance of election, in favor of setting up construction committees. With the same general objective A. P. Greensfelder proposed that the League maintain close touch with the Chamber of Commerce of the United States for more effective action on such matters as construction representation, city and state planning, stabilization, public works planning, abolition of gas tax diversion, and the like.

The assembly after full discussion of the proposed additional public works appropriation voted to endorse the pending LaFollette bill for a 3-year program. A. J. Hammond, in reporting for the research committee, referred to the importance of developing a plan for public works, the absence of which made the CWA less valuable than would otherwise have been the case. While Mr. Hammond offered no specific plan for research he urged that it receive attention in view of the continuing demand upon every industry to produce a better product at less cost.

Discussion of the construction code was opened by S. F. Voorhees, former chairman of the code committee and now head of the construction code authority. The work of the code committee has been concluded and its files will be turned over to the

(Continued on p. 619)

Bond Rejection By Michigan Limits PWA Aid

REJECTION of the proposed $38,000,000 bond issue in the state of Michigan by a five to one vote at the special election held April 30, as noted briefly in our news pages last week, has limited the amount of aid that the Public Works Administration can give to the state. The Public Works Administrator Harold L. Ickes, in commenting on the bond issue vote, said, "Rejection of the proposition put to the voters by their own state authorities leaves the state largely prevented by its own regulations from fuller participation in the PWA program. Despite the desire of the PWA to aid Michigan, the local obstacles which heretofore hampered the state's participation remain."

No definite reason can be given for the overwhelming defeat of the bond issue but it is believed that it was due largely to the activity of taxpayers leagues which, disregarding the value of assets created by public works construction and the indirect benefit derived through the travel of the wage dollar through trade channels, opposed further public work as a means of employment relief and favored direct relief on the ground that it required less money.

Another factor that may have had a bearing on the vote is the quite general belief in Michigan that the Public Works Administration has lost sight of the employment objective of the public works program and now takes a strictly banking viewpoint in considering loans for projects put up to it for financing.

Automobile Employment

Automobile production in the Detroit area is near the monthly peak and employment is at about 60 per cent of the 1929 peak yet 24 per cent of the population of the state still is on welfare rolls.

Detroit subway bonds

Public attention in Detroit now centers on the city's $88,000,000 subway bond issue, approved at the election last fall, now before the PWA for a loan and grant on a self-liquidating basis, repayment to be through fares with 30-year bonds put up as collateral. On May 5, Secretary Ickes advised Mayor Couzens of Detroit that because of the $3,500,000,000 in loan-and-grant applications now before the PWA it might be difficult to find the $88,000,000 for Detroit subway work, unless Congress made more money available.

Other Detroit projects under consideration by the PWA are $3,200,000 for slum clearance and $1,400,000 for incinerators. A request for a combined loan and grant of $1,200,000 for swimming pools has been reduced to $40,000 at the suggestion of the PWA board of review. Similarly the Water Board project has been reduced from $1,800,000 to an application for a 30 per cent grant of $540,000, the board to finance the remainder of the work. The Public Lighting Commission has reduced its application from a combined loan and grant to a grant of $390,000.

Actual allotments so far made by the PWA to Detroit are $300,000 for street paving and $21,000 for sewers. In the whole state 21 projects totaling about $2,500,000 have been financed by the PWA.

Construction Code Provides Main Topic At A.G.C. Spring Board Meeting

A DISCUSSION of the construction code, its application and operation, and of other codes affecting the construction industry, featured the spring board meeting of the Associated General Contractors of America, Washington, May 4 and 5. Several members of the executive committee of the A.G.C. who are also members of the General Contractors' Divisional Code Authority answered hundreds of questions concerning the code. From the nature of the questions asked it is apparent that much confusion exists as to the scope and application of the code.

Stephen F. Voorhees, chairman of the Construction Code Authority, and A. E. Horst, chairman of the Contractors' Divisional Code Authority, talked on Chapters I and II, respectively. B. L. Knowles outlined the work his committee has done in connection with codes of industries related to construction, such as lumber and building supply dealers. He stated that this committee had apparently won its fight to liberalize the lumber code to permit contractors to buy direct from the mills in carload quantities. Several mark-ups in the builders' supply dealers code regarded as excessive by the contractors have been reduced, according to Mr. Knowles.

Enforcement urged

Mr. Voorhees pointed out that the code offers an opportunity for the integration of the construction industry for the first time. He pleaded for cooperation in enforcing the competitive bidding practices section of the code, violation of which would seriously cripple the effectiveness of the code. Enforcement of the code is going to be difficult, he said, because of the large number of employer units affected, more than 100,000, by far the greatest in any of the durable goods industries. Prior to the establishing of the compliance machinery which has not yet been set up, the burden of compliance work will fall on the divisional code authorities, as the Construction Code Authority is merely a correlating body.

Registration agencies have been set up in all but six states. Until permanent state boards are formed, the A.G.C. units have been designated as registration agents. The permanent state boards will be responsible for the administration of the contractors' code in their respective states.

MEADOWBROOK CAUSEWAY FILL ON LONG ISLAND COMPLETED

A new entrance to Jones Beach, the extensive ocean-front park of the Long Island State Park Commission, will be completed next fall. Known as Meadowbrook Causeway since it originates in Meadowbrook State Park near Freeport, the new construction includes a branch to Long Beach, as shown in the accompanying view in which the white lines correspond approximately to the location of the future bituminous macadam roadway, bids for which were opened on April 24.

The new causeway, about 5 miles west of the existing causeway from Wantagh, required the placing of 10,000,000 cu.yd. of sand fill, material being dredged along designated routes, thus forming a series of new ship channels 200 ft. wide and 15 ft. deep. Current construction involves ten bridges comprising four grade-separation and six channel crossings, two of which include bascule spans. Some 1,700 concrete piles, up to 24 in. square and 95 ft. long, cast at a plant located at the intersection of the Long Beach Loop with the main causeway, have been driven for these structures.

The Meadowbrook Causeway, financed by a $5,050,000 RFC loan, to be amortized through a 25c. toll charge on it and the Wantagh Causeway, is being built by the Long Island State Park Commission, of which Robert Moses is president and Arthur E. Howland chief engineer. Sidney Shapiro, in charge of engineering, is supervising the work.

according to present plans of organization. Procedure for the establishment of area labor agreements is now being formulated.

Subdivisional codes for building contractors, heavy construction contractors and highway builders are about complete and hearings will be held soon. Daniel T. Webster, New York, C. V. Burghart, Chicago, and R. E. O'Connor, Ft. Wayne, are chairmen of these subdivisional code committees, respectively.

"In regard to further public works funds, we believe it would be fatal to recovery for Congress to be parsimonious in its appropriations for the coming year," E. J. Harding, managing director, A.G.C. stated. "We look for a fairly active summer in the construction field, as a result of the allotments made under the National Industrial Recovery Act, but unless that program is substantially augmented and continued for at least another year a complete collapse of construction employment threatens."

A.G.C. membership increases

The membership of the A.G.C. has increased about 50 per cent in the past year, according to reports; 22 new chapters have been formed since the first of the year, and several more applications for chapter charters are awaiting action.

Resolutions passed at the meeting asked for a public-works fund for the coming fiscal year at least equal to that of the current year, endorsed the Cartright bill for highway appropriations, asked that governmental agencies operate under the Construction Code, objected to the Trucking Code provision calling for registration and a fee for "not for hire" trucks, and asked for a removal of the stay order exempting real-estate development companies from the Construction Code.

Law to Permit PWA Financing By District of Columbia

A bill enabling the District of Columbia to borrow money for financing public works from the PWA in the same way and on the same terms as other municipalities passed the Senate April 27 and similar action is expected in the House. The legislation was prompted by the objection of Administrator Ickes to assumption by the federal government of the entire cost of projects that are local rather than federal in character. He insisted that the District should exhibit willingness to shoulder the cost on the same basis as other cities. As the largest taxpayer in the District, the federal government may pay indirectly the major portion of the cost of local improvements but the Administrator felt that the District should assume responsibility.

The board of commissioners conferred with the PWA administrator and sponsored the bill introduced by Senator King, chairman of the Senate District committee that would authorize the District to apply for allotments totaling $20,000,000. The projects scheduled for financing include a sewage disposal plant, $8,000,000; tuberculosis hospital, $2,000,000; schools, $2,000,000; park land purchases and development, $2,000,000; Lorton reformatory dormitories, $500,000; the first unit of a municipal center and an addition to Gallinger Hospital for which costs have not been definitely estimated.

Appeals Board Named By Construction Code Authority

AT its meeting of May 4, the Construction Code Authority elected the nine members of the Construction Appeals Board according to the rules and regulations for its establishment which had been approved by the Administrator. The board has a balanced constituency consisting of one architect, one professional engineer, three general contractors and four special contractors. The members elected are:

- Franklin O. Adams, Adams and Hamilton, Architects, Tampa, Fla. (architect member)
- Wilson T. Ballard, J. E. Greiner Co., Baltimore, Md. (professional engineer member)
- John W. Cowper, John W. Cowper Co., Buffalo, N. Y. (general contractor member)
- R. B. Howland, United Engineers and Constructors, Inc., Philadelphia, Pa. (general contractor member)
- W. R. Smith, Lane Construction Company, Meriden, Conn. (general contractor member)
- Harry M. Hart, L. H. Prentice Co., heating, piping and air conditioning contractors, Chicago, Ill. (special contractor member)
- J. M. Krafft, Krafft Murphy Co., contracting plasterers, Washington, D. C. (special contractor member)
- E. A. Rule, masonry contractor, Washington, D. C. (special contractor member)
- J. J. Shanahan, plumbing contractor, Norfolk, Va. (special contractor member)

The members were elected for a period of one year. Nominations were made by the sponsors of the code in their respective classifications. The rules excluded nominations of any member of the Construction Code Authority, of a divisional code authority or an administrative committee thereof, or of an officer or paid employee of any sponsor, in order that the members of the board would not be acting on appeals or complaints with which they had previously had a direct interest.

Under the provisions of the code, the board has two major functions: (1) the hearing and determination of appeals from decisions of divisional code authorities; and (2) the deciding on controversies arising between the provisions of the various chapters of the code. It is expected that this industry tribunal will settle most of the conflicts within the industry, although its decisions may be appealed to NRA. It is one of the distinctive features of the Construction Code and one of the major advantages of unifying the various divisions of the construction industry under one code.

It is expected that a call will be issued within a few days for the organization meeting of this board. Already, questions have arisen which will go to the board for decision. The board will establish its own rules of procedure, subject to the approval of the Administrator, and has power to impose a uniform fee in an amount not less than $10 nor more than $25 for the filing of any complaint or appeal, and to impose such additional charges as are reasonable covering investigation and hearing. The activities of the board will be financially supported by the Authority.

Trade practice complaints

The Construction Code Authority has authorized the executive committee to establish a National Trade Practice Complaints Committee and such regional and local committees as it may deem necessary for the consideration and determination of trade practice complaints in any branch of the industry for which no divisional code authority shall have been established.

Explaining the code

The Construction Code Authority is being deluged with requests for explanations of the provisions of the construction code. In addition to the six explanations issued recently (*ENR*, April 26, 1934, p. 550) two others were issued May 4.

Explanation No. 7 deals with a highly important aspect of the code which has been misunderstood by both general and special contractors. The general contractor who asked for this ruling stated that he does not take sub-bids, but figures all of his own work in preparation of his general contract bid; and if awarded the bid, he then invites sub-bids. According to his reading of the code, this method was prohibited, and he felt that he would be either driven from business or forced to take sub-bids before submitting his own bid. However the Construction Code Authority explains that under the code a general contractor may bid on a job without requesting or securing sub-bids in any line. If awarded the contract, he may then proceed on the basis of Article VII of Chapter I as an awarding authority to request and receive bids.

Explanation No. 8 concerns Section 7 of Article VII of Chapter I. The second sentence of this section states that "all bids to be submitted by subcontractors shall be delivered to the contractor not less than 24 hr. prior to the time set for the receipt of the bid of said contractor by the awarding authority." Asked whether sub-bids could be accepted by the contractor if mailed and postmarked at least 24 hr. prior to the time the general contractor submitted his bid, the code authority states that sub-bids must be in the *physical* possession of the general contractor 24 hr. prior to the time stated.

St. Louis Will Institute Test of City's Wage Scale Ordinance

A test case to determine the legality of its municipal prevailing wage scale ordinance will be instituted by St. Louis, because the act has been questioned by attorneys for banks interested in purchasing tax bills on public improvements. Recently contractors refused to bid on a street paving project to be financed in part by tax bills, on the grounds that the wage scale ordinance might invalidate the tax liens. The city charter provides that public improvements must be let to the lowest qualified bidder in free and open competition. New bids on the street are to be opened on May 29 and contractors have promised to bid so that the test case can be filed immediately by an affected taxpayer. An effort will then be made to advance the case on the dockets of the circuit and state supreme courts so that an early decision may be had.

Florida Buys Private Bridge And Removes Toll Charges

Following purchase of the privately owned Shands bridge across the St. Johns River at Green Cove Springs, Fla., by the State Road Department, the toll charges have been removed in keeping with the state policy of eliminating toll bridges from the state highway system as rapidly as possible. The bridge is a mile long timber structure originally owned by the St. Augustine-St. Johns Bridge Co. Original cost of the bridge, built several years ago, is estimated to have been $450,000 and the purchese price was $190,000, the amount to be paid during a two-year period.

Emergency Bulkhead Gates at Marmet Dam Tested

Tests have demonstrated the successful installation of the emergency bulkhead gates at the new Marmet dam, on the Kanawha river, under adverse conditions. The efficiency of the bulkhead gates system for these dams has been proved by the tests, according to an announcement by the local district office of the U. S. Engineers. To create a severe condition for the test, one of the roller gates was raised clear of the water, resulting in a swift current into which the bulkhead was successfully lowered. Seven of these emergency bulkheads, handled by overhead traveling cranes, can be installed at the dam in case repairs are necessary to the roller gates which constitute the operating units. The dam and the gates were described in *ENR*, Sept. 21, 1933, p. 337.

Contractor Sues Hartford, Conn., For 15-yr. Old "War Costs"

A suit has been filed by C. W. Blakeslee and Sons, New Haven, Conn., against Hartford, Conn., alleging that the city owes $142,000 with interest since 1919 for work done on the Nepaug reservoir. The money sought is in excess of the original contract price for the work and resulted from increased cost of labor and materials due to the World War. History of the case shows the contract was awarded Aug. 23, 1915, and the contract price was $357,756.60. War costs, it is alleged, caused labor prices to increase 40 per cent and materials 165 per cent. The work was completed in 1919 and accepted in 1920.

The contracting company alleges that the engineer for the Metropolitan District Water Bureau, offered to modify the original contract and pay the company the actual cost above the contract price and offered to waive the penalty clause. An act of the 1919 state legislature authorized the payment.

However, Feb. 13, 1922, the city disallowed the claim, on the ground that it had been advised by attorney that the special act of legislation was unconstitutional. In 1924 the Blakeslee company sued and obtained judgment on a demurrer. On appeal to the Supreme Court of Errors the decision held the special act of 1919 was constitutional. As a result the present suit has been filed to collect the excess cost and interest.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

NEW YORK STATE PROFESSIONAL ENGINEERS, seventh annual meeting will be held May 26, New York City.

WESTERN SOCIETY OF ENGINEERS elected the following officers for the coming year: C. C. Whittier president, Leigh S. Keith, C. R. Knowles and L. R. Howson vice-presidents and C. W. Haupt treasurer.

VIRGINIA SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS elected the following officers for the coming year: W. D. Faucette president, J. L. Newcomb, R. Keith Compton, W. D. Taylor vice-presidents and P. A. Rice secretary-treasurer.

British Drought Results in Emergency Measures

A deficiency of 9.6 inches in the rainfall in England during the past year has resulted in the government taking immediate emergency measures to protect the nation's water supply. The Thames Valley is experiencing the driest year on record and the Kennet River is reported to be dry sixteen miles from its source. Premier MacDonald is rushing a bill through Parliament authorizing local authorities, for a six months' period, to develop new supplies without requiring parliamentary sanction, as now required by law.

Delaware and Raritan Canal Taken Over by New Jersey

Control and operation of the Delaware and Raritan Canal will be taken over by the New Jersey State Highway Commission according to a law recently passed by the legislature. The canal is 44 miles long, with a 16-mile feeder, having a northern terminus at New Brunswick and southern end at Bordentown. The Pennsylvania Railroad, which has controlled the canal for a number of years under the rights of an old charter, offered it to the state last year. Reports indicate that federal money will be requested to repair and rehabilitate this waterway for the use of commerce.

The legislature also passed an enabling bill creating a 5-member Passaic Valley flood control commission with authority to borrow $12,000,000 of federal funds.

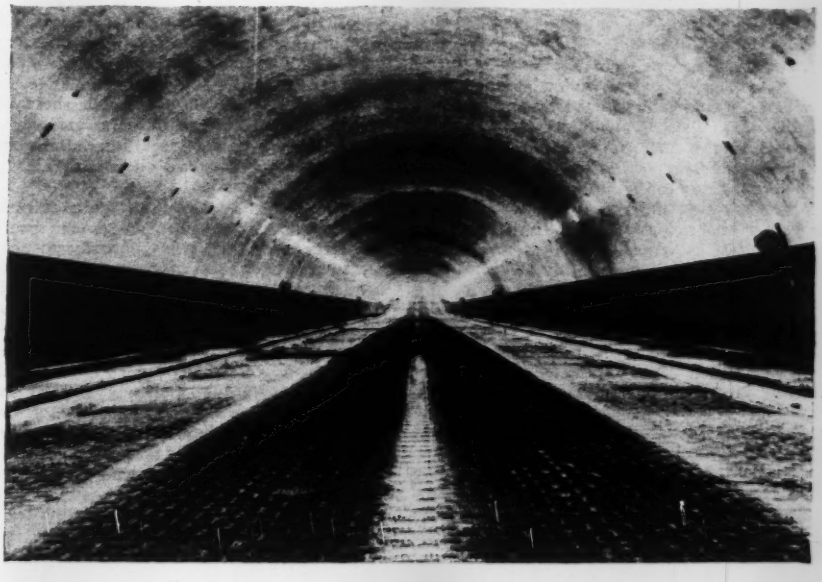
Public Toll Bridge Authorized Across Mississippi River

The Senate has passed and sent to President Roosevelt for his signature a bill authorizing East St. Louis, Ill., to construct and operate a toll bridge across the Mississippi River between Missouri Ave. in East St. Louis and Franklin Ave. in St. Louis, Mo. The city has already applied for a PWA grant and loan of $3,400,000 to finance the project. Tentative plans prepared by G. A. Maney, consulting engineer, Northwestern University, Evanston, Ill., call for a bridge about two miles long of reinforced concrete and steel construction with five vehicular lanes and sidewalks for pedestrians.

VEHICLE TUNNEL NEARS COMPLETION AT LIVERPOOL, ENGLAND

The vehicle tunnel under the Mersey River between Liverpool and Birkenhead, England, is approaching completion and will be opened to traffic some time this summer. The under-river section of the tunnel, 5,274 ft. long, is of circular section and outside diameter of 46 ft. 3 in. The accompanying photograph shows the completed roadway which is 36 ft. wide. It is paved with cast iron blocks throughout except for a short experimental section of rubber paving near one end. Lines of amber colored rubber blocks set into the cast iron paving are to be used to mark the traffic lanes.

The side walls along the walkways are of black glass. Above is a cream colored gypsum plaster with a gloss finish. A description of the Mersey tunnel was published in *ENR*, Nov. 16, 1933, p. 581.



Planning Is Discussed at Chamber of Commerce Meeting

Recovery movements in industry, finance and commerce were both the broad general theme and the detailed business of the twenty-second meeting of the Chamber of Commerce of the United States, held at Washington May 1 to 4. Code problems took a prominent place not only in the general meetings and dinner addresses but also in the group sessions, three of which were exclusively concerned with code policies, compliance, protection and price control, and the like.

Engineering and construction occupied two important sessions, one concerned with regional and city planning including public works and the other with recovery of the capital goods industries. The former expressed the new recognition of the direct relation between sound community planning and general economic stability. Such matters as the stability of real estate values, housing improvement, public expenditures and public works programs have been brought into prominence by depression experience, and their inter-relation with community planning is recognized even in the business circles far removed from relation to local government. The capital goods industries session was an acknowledgment of the now well-known fact that these industries contributed most of the unemployment and at present are key points in the recovery campaign. Papers devoted to public works, by Nick F. Helmers and Harrison P. Eddy and to capital goods problems by Malcolm Muir and Ralph E. Flanders are abstracted on pp. 610 and 611 of this issue. The planning session is briefly considered in what follows.

Planning and public works

Large-area regional planning for economic improvement and provision of better public facilities for utilization of natural resources were discussed by George L. Radcliffe, first vice-president of the Fidelity and Deposit Company of America and district chairman for the National Planning Board at Baltimore. Harland Bartholomew, engineer, city planning commission, St. Louis, outlined the fundamental principles which should govern city rebuilding, a step which he indicated to be an economic necessity as the result of uncontrolled expansion and deterioration during the past fifteen years.

Mr. Radcliffe, after reviewing the methods of planning developed by the regional advisor of PWA mentioned as a special difficulty the lack of economic data. He gave some specific illustrations of detailed planning studies by citing the considerations effecting the plan for a major parkway in the eastern part of the region and the questions entering into comprehensive study of the Chesapeake Bay problem.

Mr. Bartholomew predicted that city growth will continue in spite of all the decentralization influence, but in view of the great difficulties involved in its development and operation the average city has become unsound and requires to be built up.

Jacob L. Krave, planning consultant of the National Planning Board for Illinois and Wisconsin, advanced the suggestion that because of the lack of local perspective in respect to planning a Metropolitan Construction Authority might prove to be an effective agency to carry out major improvements.

Serious Utah Drought Demands Emergency Conservation Plans

FACED by the most serious water shortage in many years the state of Utah has taken emergency measures to meet the crisis and a decree by Governor Henry H. Blood calls on all citizens to join in a definite program of conservation and prevention of waste.

A recent survey of the water supplies available for the coming summer and fall season indicates the stream flow will be the lowest in twenty years, snow surveys show the average depth is about half the depth of a year ago, which means an exceptionally dry year will follow one which was also decidedly sub-normal. The general precipitation from October to March has been about 60 per cent normal.

With only 55,000 acre ft. of water available for use from Utah Lake for the coming season, which is one-third of the supply used in 1933 when crops were matured only with great difficulty, T. H. Humpherys, state engineer, has set a precedent in announcing his supervision over the distribution of the lake water for the coming season. This water provides for the irrigation of more than 50,000 acres of land and also furnishes indirectly a part of the Salt Lake City supply through exchange agreements. The state engineer is designated by law as the authority to administer water rights in Utah and the present case is intended primarily and solely for meeting the present emergency and does not prejudice the several rights and claims to Utah lake water supply which at the present time are involved in considerable controversy.

Parts of the Governor's proclamation, indicating the seriousness of the situation follow: "Whereas a condition of unprecedented drought at present prevails over the inter-mountain region apparently centering in Utah, and

"Whereas a danger exists that in the absence of beneficial rainfall it will be impossible to mature crops, including grains, orchards and garden products and that in some sections even water for live stock and culinary purposes will fail, which I am informed may result in enforced temporary abandonment of farms and ranches, and

"Whereas the pinch of water shortage will inevitably be felt in large and small communities, unless weather conditions change soon, so that all citizens are likely to feel the privation,

"Now, therefore . . . I call upon officials of city water companies and water users associations and citizens generally to join in a definite program of conservation of all available water within the state of Utah to take definite steps to prevent all misuse or waste of water."

To put this program into effect the Governor appointed George D. Clyde, Utah State Agricultural College Experiment Station, as special representative "for the conservation of water during the emergency." It is hoped that arrangements can be made with the owners of prior water rights to get them to share with users having junior rights, under satisfactory agreements, so that orchards and live stock can be saved.

Because of the emergency the federal government has authorized the state director of FERA to finance a state-wide drought survey. The purpose of the survey will be to ascertain the threatened or actual suffering which may result from the lack of water supply for any particular community or area of the state and to prepare a plan of improvement that can be made in the immediate emergency to provide more effective use of the available supply and to reduce losses to a minimum.

The seriousness of the situation is indicated by the remarks of Governor Blood in opening a meeting called to study the situation when he said, "The condition is critical. We must save the people out on the farms if at all possible."

Construction Code Manual to be Compiled by Construction League

A comprehensive manual of information on the Construction Code in all of its divisions will be compiled by the Construction League of the United States. Starting in June the manual will be published quarterly, with weekly supplements containing the latest information on interpretations, rulings and other pertinent information. Each quarterly issue will be complete, supplanting and combining all previous information. The manual is intended to present full information on the Code, the full text of all of the Divisional Codes, the National Recovery Act, registration, code authority membership, National Construction Planning and Adjustment Board and explanations and interpretations as they are released. The price of the four quarterly issues and weekly supplements will be $10 per year. (Construction League of the United States, 1741 New York Ave., N. W., Washington, D. C.)

Hydraulic Problems Subject of Joint Society Meeting

The broad term of fluid mechanics as applicable to the field of hydraulics and aeronautics will be the subject of a joint meeting of the aeronautics and hydraulics professional division of the American Society of Mechanical Engineers and the American Association for the Advancement of Science to be held at Berkeley, Calif., June 19-21. The first day of the meeting will be devoted to the underlying theories of fluid mechanics involving both of these fields, to be followed by parallel sessions covering aeronautics and hydraulics, including hydrology and agricultural hydraulics. Baldwin M. Woods, chairman of the department of mechanical engineering, University of California, is chairman of the general arrangements, and Wm. F. Durand,, Stanford University, is honorary chairman of the meeting.

Houston, Texas, Will Complete Unfinished City Projects

A construction program which will finish more than $1,000,000 worth of uncompleted municipal projects, some of which have been pending for five years, will be instituted by Houston, Tex. On the recommendation of Mayor Holcombe, the city counsel authorized the controller to advertise for bids on bonds totalling $1,086,000.

Construction League Admits State Groups

(Concluded from p. 614)

League. The possibility of having a continuing code committee was suggested as worth considering. Speaking of the present situation of the code Mr. Voorhees remarked that seven chapters, following the general chapter, have been adopted, and that the engineers' and architects' codes are probably nearing approval, while building, granite, plumbing, roofing, marble contractors are almost at the same point. Plasterers and heating contractors, terrazzo, resilient flooring and insulation contractors are well advanced. It is expected that pipe line contractors who have been seeking a separate code will have a chapter of the construction code. Difficulties in respect to the bituminous paving industry, river and harbor contractors and structural steel fabricators are approaching solution.

Serious problems in code administration were brought out particularly by John V. Dewar of the Master Painters, and John H. Zinc of the Heating and Pipe Contractors. The Master Painters have set up a regional code agency in each state and local agencies in the cities. The organizational system, Mr. Dewar said, is frankly designed to strengthen the trade association, which has doubled its membership in the last two months. However, the painters are greatly concerned about the slowness of the NRA as to area agreements for labor, since 80 per cent of painting cost is pay roll. Without prompt action on area agreements, he remarked that the code was worthless. Area agreements are now being sent in by the local agencies, and he proposed that such agreements be made official when formulated, subject to later hearing and amendment. He expressed fear that this spring's business will go by without area agreements.

Oscar A. Reum expressed himself similarly in respect to problems in plastering.

PWA regulations relating to compensation of engineers at the site of the work and cancellation of contracts for violation of codes were discussed and a protest to Secretary Ickes was voted.

Addresses by Malcolm Pirnie, chairman of the Public Works Committee of the American Society of Civil Engineers, on the status of the public works campaign, and by Willard Thorp of the Department of Commerce, on the real property inventory gave important information. Mr. Pirnie gave figures to show that with full allowance for the present PWA program a decline in employment is to be expected after midyear and that the accumulated deficit in public works by the end of 1934 and 1935 respectively will amount to 3½ billion and 5 billion unless steps are taken to continue the program. No private construction of any volume is looked for until 1937 but is likely then to develop as a boom activity. He urged that the Government continue the works program until confidence is restored. Thomas G. Cutler, Harrison P. Eddy, and A. P. Greensfelder, supported Mr. Pirnie's argument.

Mr. Thorp presented figures from the first ten cities covered by the real property inventory and showed that in more than 100,000 dwellings 4 per cent were found unfit to live in, 20 per cent needed structural repairs and 36 per cent minor repairs.

Date Set to Hear Building Code Highways and Heavy Construction

May 21 has been set as the date for public hearings supplemental codes to the basic code for the construction industry for the following subdivisions of the industry: highway contracting, building contracting and heavy construction and railroad contracting. The hearings will be held in Washington in the auditorium of the Department of Commerce Building beginning at 10 a.m. May 21. They will be held under the direction of Deputy Administrator B. R. Value.

Washington Notes

By Paul Wooton
Washington Correspondent

Sentiment in Congress is swinging toward a large public works bill and the $3,500,000,000 measure proposed by the Construction League appears to be acceptable to many congressmen who must stand for reelection this fall. Fifty or more congressmen, elected on the Roosevelt landslide, are anxious to secure specific public works projects for their districts not provided in the present small administration bill. In any measure providing for appropriation of federal funds, public works will have to compete with school-aid, and other vote-producing proposals, but construction is the form favored by the majority.

As strategy, the introduction of the $3,500,000,000 public works bill is well-timed and represents a figure which the President cannot brush aside with the same assurance as Senator LaFollette's $10,000,000,000 program on which desultory hearings are still in progress. There is evidence of strong feeling against a lump-sum appropriation for allocation by Administrator Ickes. Representative Goss of Connecticut, Republican, voices the sentiment of many Democratic congressmen, stating that any additional appropriations for the PWA must be ear-marked by Congress and spent only on authorized projects.

The foremost public works measure at present is the $400,000,000 highway bill scheduled to come up on the floor May 10, under a rule permitting two hours of debate and amendments from any quarter. This procedure is the outcome of a growing protest against the gag rule in the House. Leaders feared that the highway bill may become a grab bag forcing the President to meet the issue on the public works question.

Charges of extensive "kick-back" racketeering on federal construction projects prompted a statement from Administrator Ickes that the PWA is doing everything possible to exterminate this despicable practice. Where the full amount of pay is put into pay envelopes and later returned, Secretary Ickes said that there may not be any legal redress possible but strong public opinion can be brought to bear.

Secretary Ickes intends proposing an amendment to the municipal bankruptcy bill to exclude the bonds purchased by the PWA from adjustment, claiming that it is unfair, in many instances, to expect the Federal Government to assume a deduction after having contributed 30 per cent to the cost of municipal projects.

Spread of PWA Funds Continues as Cities, Financing Improves

CONTINUED improvement in the market for municipal securities with the resulting ability of cities to finance their own public works projects has already released almost $24,000,000 of PWA funds for reallotment to other projects which were on the waiting list when the original allotments exhausted the $3,300,000,000 fund.

During the past week the requests for allotment change have totalled 28 which have reduced the loan and grant requirement of $1,617,374 to grants totalling $465,100, which releases $1,152,274 which has already been reallotted.

These changes include eight small projects at Madison, Wis., the largest being a loan and grant of $183,200 for improvements to the water distribution system, which has been reduced to a grant of $59,000. The other large project was the reduction of a loan and grant of $356,000 to Cincinnati, Ohio, for construction of its sanitary outfall sewer which has been reduced to a grant of $89,400.

New non-federal projects

Release of funds has permitted the PWA to announce allotments totalling $300,400 for the construction of five non-federal projects for 30 per cent grants, the recipients being able to provide the balance of the financing from other sources. These new allotments are: Cincinnati, Ohio, $90,500 grant for sewers and sidewalks and $85,000 for street improvement; Harris, Tex., $112,000 for street work and Rhinelander, Wis., $13,000 for school buildings.

Rescinded allotments

Among the eight allotments rescinded the two largest are a $435,700 loan and grant to Fond du Lac, Wis., for miscellaneous public improvements and $142,000 loan and grant to Chandler, Okla., for a municipal light and power plant.

Among the important reductions made in previous allotments is the change of the $3,555,000 loan and grant to the Regents of the University System of Georgia for construction work on institutions under its jurisdiction to $2,817,400. The largest increase in allotment announced was the raising of the $400,000 loan and grant to Morgantown, W. Va., for dormitory construction at the University of West Virginia to a figure of $625,000. The other changes in allotment were relatively small.

Two more high speed trains financed

An allotment of $900,000 has been announced by the PWA for the Baltimore & Ohio Railroad Company for financing the construction of two high-speed trains. The money will be used to purchase sixteen coaches and a diesel-electric engine. The B&O is planning to build a steam locomotive to draw the second train so that comparison can be made of operations. Each train is scheduled to consist of six cars and locomotive with four cars to be held in reserve. All cars will be air conditioned. The railroad company has awarded the contract for building the trains to the American Car & Foundry Company.

Brief News

CONTRACTS have been let for the construction of 76 dwellings in the village of Grande Port by the Freeport Sulphur Co. at Lake Grande. The contracts total about $125,000.

FORTY-TWO MEN were arrested in Monroe, Ohio, for making a demonstration against FERA workers there on May 3. Each was fined $25 and costs with the fine to be worked out at the rate of $1 a day. The demonstrators were seeking to stop all FERA work in the county.

HAVING REACHED an understanding with representatives of the Illinois Power & Light Co., resulting in a reduction of $1,700 in the annual rate for city street lighting, the city council of Chester, Ill., has decided to abandon plans for a municipal power plant and has decided to withdraw its request for a $158,000 loan and grant from the PWA.

THE REGIONAL LABOR BOARD, Buffalo, N. Y., has rendered a decision that the Niagara Falls Builders' Association shall pay members of the local carpenter's union at a basic wage rate of $1 an hour. Both parties have agreed to submit the wage issue to a committee for arbitration.

Obituary

BROOKE G. BIRD, 46 years old, assistant engineer in the sewerage department of Baltimore, died suddenly at his home May 3.

ARTHUR DEMERRICK MARBLE, formerly city engineer of Lawrence, Mass., died April 30 at the age of 81. He had spent most of his professional life in the engineering service of Lawrence, which he had headed for many years. He had been retired since 1919.

KORT BERLE, well known structural engineer of New York, associated with the design of many important city buildings, died May 5, at the age of 68. He was born and educated in Norway and his first position in this country was with the Phoenix Bridge Co. Later he entered the federal service as engineer in the Treasury Department, serving as chief engineer of that organization from 1902-1905. In 1909 he came to New York as partner in the consulting firm of Gunvald Aus Co., Inc., and during succeeding years he was engaged in the structural design of many important New York buildings including the Woolworth Building, the New York Life Insurance Building, as well as many federal and state governmental structures.

CONSTRUCTION STATISTICS OF THE WEEK

PUBLIC ENGINEERING awards this week, at $13,733,000, are about 30 per cent below last week, while private awards at $5,958,000 are 5 per cent above. The total, $19,691,000 is 22 per cent below last week, 17 per cent below the average week to date and 7 per cent above the average May week last year. Both federal and state and municipal awards are down.

The drop in public work is largely in highways, which at $4,348,000 are $5,458,000 below last week. The earthwork, irrigation and drainage classification is very low this week, waterworks are down to $652,000, and sewerage declined to $1,341,000. Bridges at $3,205,000 are below last week but well above the average week to date. Public buildings are up to $3,229,000 and commercial buildings register the highest week for this year.

Larger contracts include the Hopedale shop for Draper Corp., Massachusetts, $500,000; the East Boston Neptune Gardens, Inc. building development, $4,000,000; the state highway letting by Montana, $530,000; the Calumet Intercepting sewer, Chicago, $1,030,000; and the Coos Bay Bridge, Oregon, $2,123,000.

Municipal bond sales this week, $4,272,000, were practically the same as last week. These were offset by a withdrawal of $2,254,000 of PWA funds due to the excess over reallotments for public work of cancelled and decreased loans and changes from loans and grants to grants only. Of this amount $1,075,000 was realloted for administration purposes.

CONTRACTS

(Thousands of Dollars)

	Weekly Average May 1933	Week Prev. 4 Weeks	May 10 1934
Federal Government	$751	$5,727	$2,252
State and municipal	14,360	16,224	11,481
Total public	$15,111	$21,950	$13,733
Total private	4,438	4,743	5,958
Week's total	$19,549	$26,693	$19,691
Cumulative to date: 1933	$325,936	1934	$449,050

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1934	Week May 10	Cumulative
State and municipal	$4,272	$112,449
PWA allotments, S&M	−2,254	187,324
Corporate issue	393	13,975
PWA allotments, private	900	50,381
Total, Non-Federal	$3,311	$364,129
PWA allotments Federal Constr.	21	49,436
Total new capital	$3,332	$413,565
Cumulative to date: 1933	$102,674	1934 $364,129
Rescinded or reduced allotments (from 1933 PWA totals)		$43,323

NOTE: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

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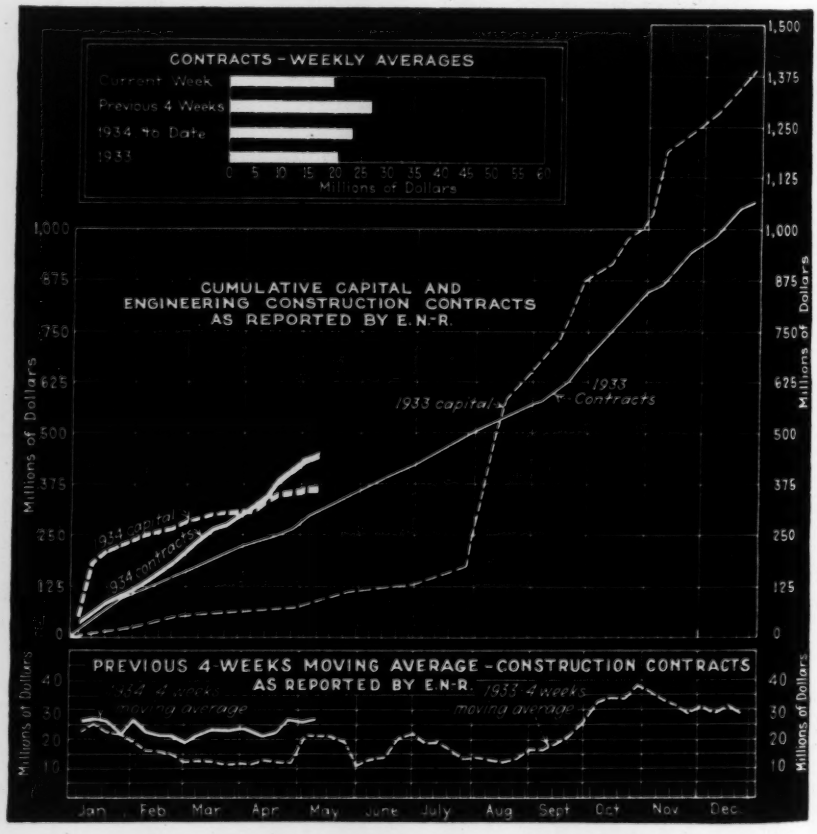
E.N.-R.-Cost		E.N.-R.-Volume	
May, 1934	199.61	April, 1934	109
April, 1934	195.86	March, 1934	108
May, 1933	164.39	April, 1933	65
1933 (Average)	170.18	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100